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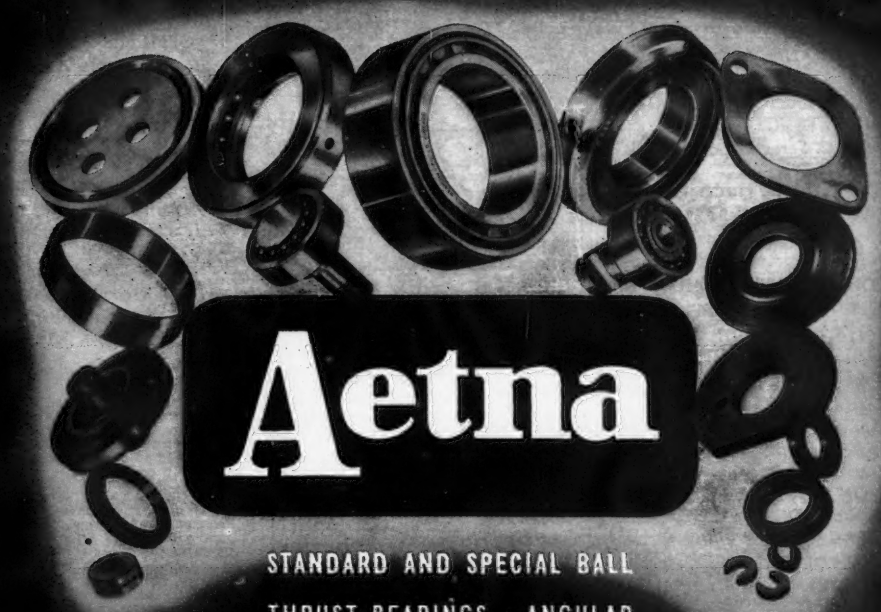

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EDITORIAL

Our Most Serious Professional Problem

By J. Dewey Long
FELLOW AND PAST-PRESIDENT, A.S.A.E.

THE future of any profession is dependent upon the preparation of an adequate number of young men to serve as replacements and to take over new areas of responsibility which have been developed. Agricultural engineering is sufficiently mature as a profession to have need of a considerable number of replacements annually. More important, it is being recognized by the industry it serves to such an extent that there are many new fields of professional activity being opened. It is probable that our rate of growth over the past decade is one of the largest among the engineering professions.

The continued growth of the profession and its ability to render its full potential to the agricultural industry depends upon an increasing number of adequately trained graduates each year. To accomplish this will require more colleges offering professional agricultural engineering curriculums and more students enrolled in those curriculums.

The first is in progress. Ten new agricultural engineering curriculums were accredited by the Engineers' Council for Professional Development (ECPD) at its annual meeting in October. This makes a total of 16 accredited curriculums offered in 15 states. (The curriculums at both the Berkeley and Los Angeles campuses of the University of California were accredited in 1949. The students of both institutions take their senior year with the division of agricultural engineering at the University's college of agriculture at Davis.) An equal number of college departments are preparing for ECPD inspection within the next two years.

The second requirement for more professional graduates prevents a more serious situation. At the annual ECPD meeting, Dean S. C. Hollister of Cornell University, chairman of the Committee on Engineering Schools, presented the current statistics on all engineering student enrollments compiled by his committee. His figures may be briefed as follows:

	A	*B*
1947	5+	
1948	4+	
1949	2.9	
1950	2.2	50,000
1951		32,000
1952		21,000
1953		17,000
1954		12,000

Column A represents the percentage of high-school graduates enrolled as freshmen students in engineering colleges each year. As a result of the warnings of vocational guidance people, who saw the large GI enrollments and predicted saturation of the engineering professions, high-school graduates passed by the engineering colleges in increasing numbers until only 2.2 per cent of the June graduates enrolled as engineering freshmen last September.

Column B gives the number of engineering graduates predicted through 1954. Some 30,000 graduates annually are required to maintain our economy at its normal tempo, according to Dean Hollister. But the all-time high of almost 50,000 graduates in June, 1950, was absorbed within a few weeks and industry is currently searching for more. Declining birth rates in the 1930's and fewer freshmen students over the past four years result in a startling decrease to 12,000 probable graduates in 1954. Even this number may be reduced by one-half if stringest Selective Service regulations are put into effect. And the prediction is that there will be a further gradual decline, reaching a low-point in 1963! A sharp upturn then is supposed to bring the graduate total back to a normal 30,000 by 1968.

The agricultural engineering profession cannot afford to suffer this dearth of graduates for the next decade and a half. It is time for the profession to take all possible measures to present its advantages to potential students. The college departments can be most effective in initiating dignified advertising for students by radio programs, personal contacts with high school students, and mail campaigns to vocational-agriculture high school teachers and county agricultural agents. Student branches of the ASAE should appreciate the problem and institute suitable programs for recruiting fellow students. The parent Society and individual members can exert their influence in various ways to help maintain a reasonable production of graduates.

The present trends in our national economy and in our international relations place added emphasis on our reliance on technical competence. Agricultural engineers will have an increasing responsibility in the further development of the agricultural industry. These responsibilities cannot be met unless we train qualified men in sufficient numbers.

Accreditation Program Moratorium

IT HAS been known for some time that college and university administrators were troubled by the numerous, and sometimes unrealistic, demands of certain educational accreditation agencies. The basic objective of professional groups in providing outside committees to ascertain that reasonable standards of curriculum content, facilities and faculty are being met is recognized as desirable. But the activities of questionable groups which have established themselves as accrediting agencies, with unreasonable demands for organization and procedure patterns and unrealistic inspection fees, have developed many administrative problems.

The committee of the Association of Land-Grant Colleges and Universities (ALGCU) which has been studying accreditation procedures, has drawn up a tentative standard which it is hoped may help relieve the confused situation. At the last annual meeting of the Association in November this committee requested all member institutions to withhold all further action on accrediting while further study is devoted to the matter.

It is understood that the accreditation program and procedures of the Engineers' Council for Professional Development (ECPD) more than meet the present proposals of the ALGCU committee. During the moratorium, college agricultural engineering departments which do not have accredited professional curriculums will have an opportunity to further strengthen their status and to be prepared for ECPD inspection when the accreditation program is resumed.

J. D. LONG

Electrification Grows

DOUBLED farm use of electricity by 1960, over the demand in 1947, is in prospect for at least one area in Iowa according to a recently published report by the Bureau of Agricultural Economics, U.S. Department of Agriculture (USDA Circular No. 852). The specific climb indicated is from 2,174 kw-hr per farm per year in 1947 to a probable 4500 kw-hr by 1960.

Approximately corresponding potential demand increases may also be in prospect for other farm areas.

Engineers and other representatives of the power suppliers, who by the very nature of their business are used to planning years ahead, are undoubtedly considering ways and means of increasing generating and transmission capacity to meet this prospective increased demand. It is also a possibility to be seriously considered *(Continued on page 634)*

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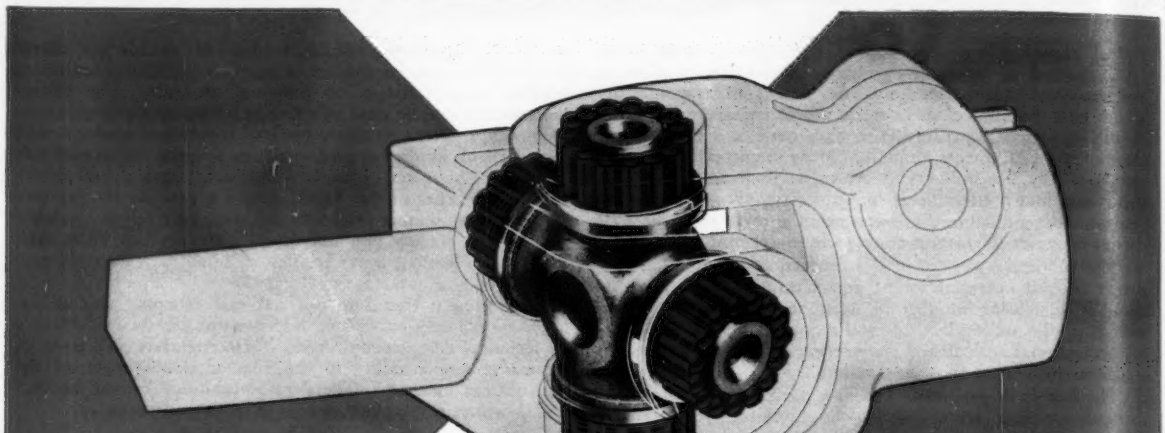

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AGRICULTURAL ENGINEERING

VOL. 31 DECEMBER, 1950 No. 12

Thermal Design of Livestock Shades

By C. F. Kelly, T. E. Bond and N. R. Ittner

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HIGH temperatures at certain seasons may turn profitable livestock enterprises into losses, even though feed and labor are plentiful. Only a relatively small part of the energy in the feed intake goes to milk, meat, fat, or eggs. The rest is discarded to the environment in the form of heat, feces, and urine; and if it is not discarded, it raises the animal's body temperature. When the body temperature rises, the animal loses appetite and reduces feed intake, with disastrous results to profits. The problem in a hot environment is to make it possible for the animal to lose its waste heat without changing its physiological reactions in any way that might interfere with its remaining on full feed.

In a cooperative study between the U.S. Department of Agriculture and the University of California, several types of shades were tested. The problem of making a rational comparison of shades on the basis of their effect on heat transfer between the animal and the environment was encountered. This paper will describe a method of thermal design of shades, using examples from the above project for illustration.

With a wind velocity of but one mile per hour, a given unit volume of air will be under a shade 36 ft long (in the direction of wind travel) for only 25 sec. Any lowering of air temperature occurs as a result of heat transfer from the air to cooler ground in the shadow or to the framework or roof of the shade, by convection, unless water is evaporated into the air from sprays or from urine and feces. As a result, little reduction of air temperature can be expected. Observations under several experimental shades constructed at the University of California Imperial Valley Field Station in 1948 indicated this. A more complete test was made in the summer of 1949. A 16-point recording potentiometer was used to obtain continuous records of air temperature at several levels under two hay-covered shades. Each was 18 x 36 ft in size, but one shade was 7 ft high and the other 12 ft (Fig. 1).

Thermocouples of 30-gauge copper-constantan wire were supported from the roofs at heights of 1, 3, and 6 ft under the low shade, and at 1, 3, 6, 9, and 11 ft under the high shade. The supports were moved hourly so that the bottom couple was always close to the center of the shadow. At night all junctions were left directly under the center of the shade. While there was some evidence of stratification at higher elevations, at the 1 and 3 ft levels, occupied by the animals, there was little difference between the two shades. Most of the benefit, as far as animal comfort is concerned, therefore, should be ascribed to a lowering of the radiation heat load and not to an increase in convection loss.

Method of Design. Each part of the surround radiates at a rate depending upon its temperature and emissivity. Since any small area on the surface of the shade, ground, or other part of the surround is radiating in all directions, only a part of this total energy will be intercepted or "received" by the animal. Similarly, the infinitesimal areas making up the cow's surface are radiating in all directions and only a portion of the energy from each area is intercepted by the shade. The net exchange of thermal radiation between the animal and its surround depends upon the difference between the two rates of emission as well as upon the shape and relative position of the radiating surfaces. Because the animal reacts to each change in its thermal environment by a change in its surface temperature and radiating rate, it is simpler and allows the same comparisons to be made if the irradiation or heat load on the animal is considered instead of the net heat exchange.

The geometrical factors relating the emission of one sur-

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

The authors: C. F. KELLY, T. E. BOND, and N. R. ITTNER are, respectively, agricultural engineer and assistant agricultural engineer (BPISAE), U.S. Department of Agriculture, Davis, Calif., and associate specialist in animal husbandry, California Agricultural Experiment Station, El Centro, Calif.

AUTHORS' ACKNOWLEDGMENT: Credit is due F. A. Brooks and R. L. Perry, University of California at Davis, for assistance in the preparation of this paper, and to L. M. K. Boelter, University of California at Los Angeles, for his inspiration.

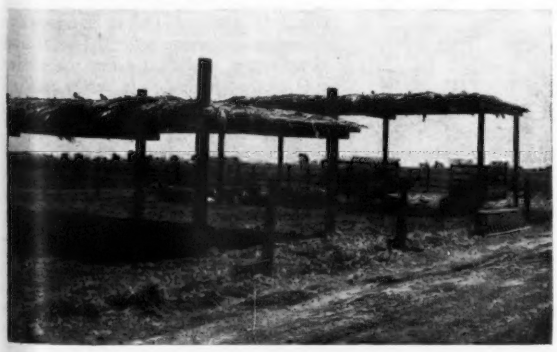

Fig. 1 Hay-covered shades for testing the effect of shade height on cattle comfort at the Imperial Valley Field Station. Note that all animals are lying under the high shade.

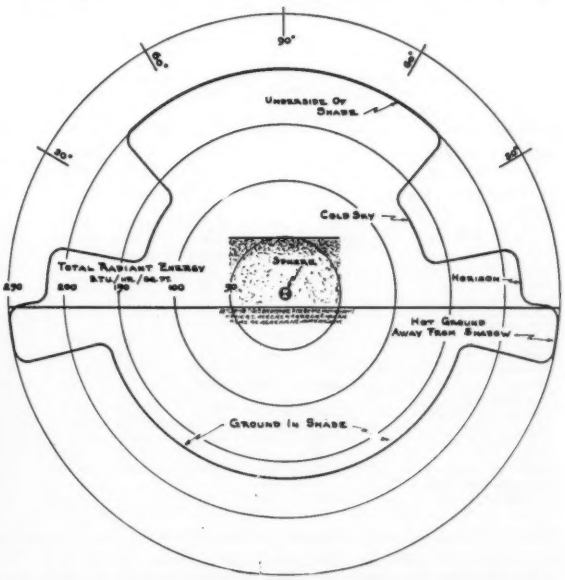

Fig. 2 Diagram indicating general magnitude of energy emission by different parts of the surround making up radiation environment for animals under shade, as measured by directional radiometer

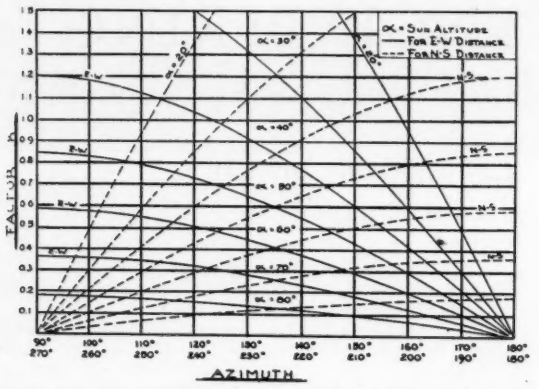

Fig. 3 Graph for determining location of shadow under a shade when altitude and azimuth of sun are known. Multiplying height of shade by factor *K* gives directly the distance of shadow from any given point on shade

face to the reception by another is called variously the "shape", "angle", or "seeing" factor. This factor may be defined as that fraction of the energy — emitted in all directions by the one surface—which is intercepted by the second. For example, if the receiving surface is at such a distance and so oriented as to receive half the energy from the emitting surface, the shape factor of the receiving surface with respect to the emitting surface is said to be 0.50. Shape factors for regular and geometrically simple cases have been determined exactly by McAdams(1)* and others, and presented as curves. So far as known, no shape factors for animals have been published. Moreover, they are difficult to use in comparing shades because of the very great changes in projected areas when viewed from different angles. An unpublished report by Perry and Speck(2) shows that the shape factor of a standing dairy cow with respect to a point on a horizontal infinitesimal surface 10 ft above the ground and 10 ft from the side of the cow is 0.025, while from the same height but 10 ft from the front it is only 0.012. The shape factor of a regular surface, such as a sphere, on the other hand, does not change with the direction from which it is viewed.

Raber and Hutchinson(3) suggest that the use of a sphere as a reference surface simplifies calculation of the mean radiant temperature and radiant heat load, but point out that the numerical heat load for the sphere is different from that for a standing person because the projected areas being presented to each radiating surface in the surround are not the same. This observation, of course, is also true for animals, although possibly to a less extent. However, for usual design purposes — such as determining the effect of various construction materials, shade height, and size — sufficient accuracy can be obtained by evaluating the radiant heat load falling upon a small sphere located at a point representing the position of the animal.

*Numbers in parentheses refer to the appended references.

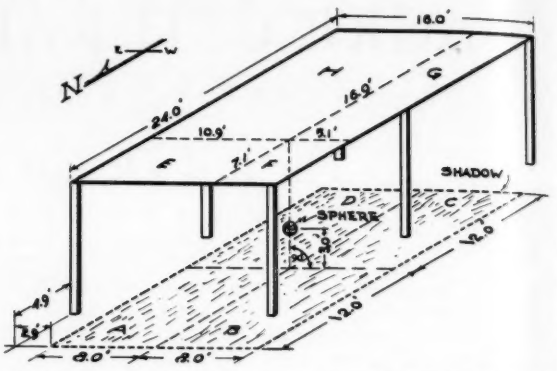

Fig. 4 Diagram of the shade used in example, showing location of shadow on September 1, 1948, and the method of dividing shadow and shade into sections for determining shape factors

Values for Radiosity†. To compute the radiant energy falling on the sphere, it is necessary to know not only shape factors, but also the rate of emission of energy by the various sections of the surround. Many observations in the field with a directional radiometer have shown that, in general, the entire surround may be divided into five parts each radiating at quite different rates: (a) The cool ground in the shadow of the shade, (b) the unshaded hot ground around the shadow, (c) the underside of the shade, (d) a band about 10 deg high above the horizon, radiating at a high rate because of back radiation from moisture in the heated air near the ground, and (e) the remainder of the sky hemisphere not hidden by the shade or included in the horizon band. This division is shown graphically on polar coordinates in Fig. 2 to indicate the magnitude of the differences between the various sections.

TABLE 1. EXAMPLES OF ENERGY RADIATED TO ANIMALS UNDER SHADES BY VARIOUS FEATURES OF THE SURROUND, FROM OBSERVATIONS MADE AT EL CENTRO, CALIF.

Example	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
Date[1]	Sept. 1	Sept. 1	Sept. 1	Sept. 1	Aug. 18	Aug. 18	Aug. 18	Aug. 22	Aug. 24
Time	11:00 a.m.	11:30 a.m.	11:30 a.m.	11:30 a.m.	10:30 a.m.	12:00 noon	12:00 noon	12:30 p.m.	11:30 a.m.
Air temperature (deg F)	106	101	101	101	96	105	105	100	104
Shade:									
Type	Hay covered	Galv. iron	Hay over galv. iron (sprays)[2]	Burlap & alum. (sprays)[3]	Galv. iron	Galv. iron	Hay over galv. iron[4]	Hay covered (6"depth)	Galv. iron
Size (ft)	16x24	16x24	16x24	21x21	16x24	16x24	16x24	16x24	16x24
Height (ft)	10	10	7½	7	10	10	7½	10	10
Radiosity (Btu/hr/sq ft):									
Ground in shadow	160	160	155	140	160	165	164	157	168
Hot ground outside shadow	210	200	200	200	260	275	275	280	275
Underside of shade	176	200	152	145	195	200	168	163	207
Horizon	205	216	216	216	215	215	215	215	240
Sky	133	145	145	145	121	130	130	142	168
Calculations:									
Sun declination[5]	7° 57.7'	8° 19'	8° 19'	8° 19'	13° 9'	13° 7.8'	13° 7.8'	11° 48.3'	11° 8.4'
Sun altitude	61° 30'	64° 30'	63° 30'	64° 30'	50° 35'	70°17.8'	70°17.8'	67° 53'	65° 27'
Sun azimuth	148°12'	158°23'	158°23'	158°23'	111° 1'	180°	180°	193°51'	162° 3'
Kw[6]	0.29	0.19	0.19	0.19	0.78	0.00	0.00	0.11	0.14
Ksc[6]	0.49	0.45	0.45	0.45	0.30	0.35	0.35	0.41	0.45
Radiant heat load (Btu/hr/sq ft)	169	176	165	157	174	186	182	179	198

1/ Examples 1 to 4 from tests made in 1948, remainder in 1949.
2/ Two roofs spaced about 3 ft apart, bottom roof kept wet with roof sprinklers.
3/ Upper roof of aluminum, subroof of burlap kept wetted with roof sprinklers.
4/ Same shade as 2/ but no sprinklers.
5/ Sun declinations from American Nautical Almanac.
6/ From Fig. 3.

The radiosity of the five parts of space mentioned above depends not only on the character of the shade construction materials but upon such factors as the intensity of solar and sky radiation, wind velocity, and air temperature. The energy from the cool ground in the shadow (a) is largely long-wave emission; that from the hot ground (b) is long-wave emission and some reflected solar and sky energy; and that from the under side of the shade (c) is partly emitted and, with highly reflective materials, partly reflected ground radiation.

Field observation at Davis and El Centro on different types of shades have given many typical examples that illustrate the method of design being discussed. Some of these values are listed in Table 1, along with the

†Boelter (4) defines radiosity as the total quantity of radiant energy leaving a surface per unit time per unit area. The radiosity may be due to energy initially emitted by a surface, to energy reflected from the surface, and to energy transmitted through the surface.

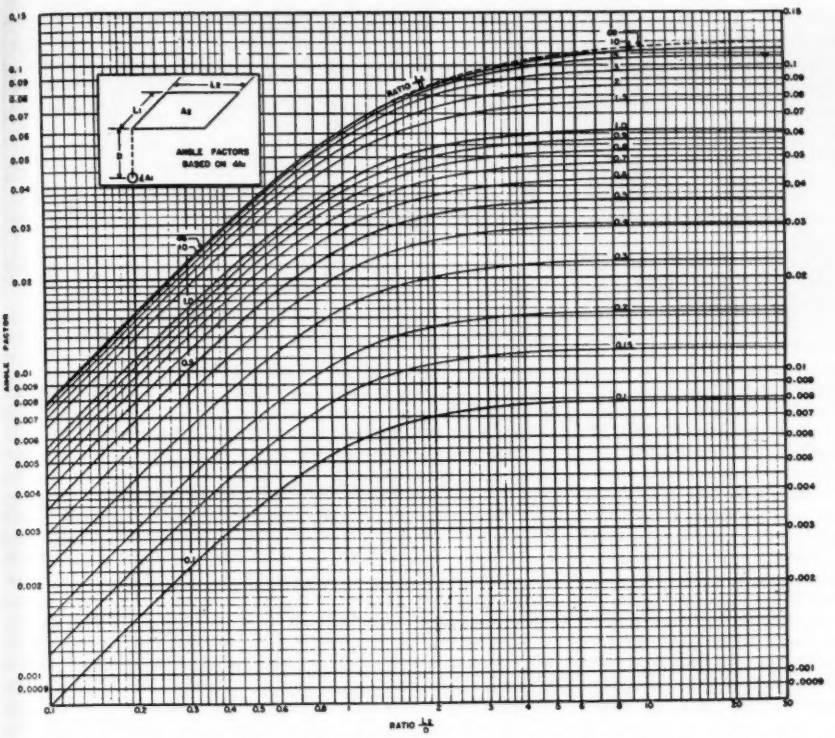

Fig. 5 Shape or angle factors for plane surfaces with respect to a sphere. (Reproduced by permission from Cornell University Engineering Experiment Station Bull. 32, August, 1943, by C. O. Mackey, L. T. Wright, R. E. Clark, and N. R. Gay)

shade descriptions and other data needed for the computations. The heat load on a sphere under each shade is given. It will be noted that the difference between the lowest and highest heat loads (or sphere irradiation) does not vary by much more than 40 Btu per hr per ft. These do not seem large when compared with the total radiant heat loads of 169, 176, etc. However, even with a "perfect" shade, we could not expect the mean spherical radiation to be less than that of the cold sky. The total heat loads under the shades of examples Nos. 2, 3, and 4, all measured at the same time (when the sky was radiating as a black surface at 89 F), were 31.3, 19.9, and 11.8 Btu per hr per sq ft higher than if the entire surround was radiating at the same rate as the sky. That the differences are great enough to be of practical significance were shown by feeding trials conducted with beef cattle under the various shades. Three summers of tests indicated that the rates of grain, feed consumption, and general comfort of the animals varied with the radiant heat loads. These tests have been reported elsewhere(5).

The relation between the microclimate and the radiosity of various materials and soils was studied at Davis this summer. The results will be reported at a later date.

COMPUTATION

Computations for determining the radiation heat load under a given shade are relatively simple after suitable values for emission rates, or radiosity, for the various parts of the surround have been determined. The steps are as follows: (a) Determine location of shadow with respect to shade; (b) determine shape factor of each of the five principal radiating parts of the surround with respect to a sphere; (c) multiply the shape factors by the respective rates of emission; and (d) add the five parts to obtain the total radiant heat load.

For illustration, the first shade in Table 1 will be used. The problem is to determine the radiant heat load on a small sphere 3 ft above the center of the shadow. (This represents the approximate center of a yearling beef animal. If the shade is to be used for poultry or swine, heights more appropriate to the size of the animal should be used.) This shade is 16 x 24 ft in size and 10 ft high. For the preliminary example the hay covering is an advantage because it reflects very little ground radiation.

Location of Shadow. Cattle seeking shelter from the sun's rays position themselves not by *shade* but by *shadow* location. The radiation heat load should therefore be calculated for some point over the shadow, without regard for the actual location of the shade itself. To compute the shape factor of the various radiating surfaces, however, the shadow location must be ascertained. This can actually be measured if the shade is already constructed. However, if it is to be designed for a season of the year, time of day, and geographical latitude different from the present, it must be calculated. Fortunately, the sun's rays are parallel when they reach the earth, and the size of the shadow under a thin, flat, horizontal shade is exactly the same as the size of the shade. Furthermore, the rate at which the shadow moves, due to the sun's movement, is exactly proportional to the shade height. For example, in one hour, a shadow from a shade 12 ft high will move twice as far as that from a shade 6 ft high. This fact has been used in constructing the graph in Fig. 3, showing the relation between shadow location and altitude and azimuth of sun, for a shade 1 ft high. Multiplying these values by shade height, will locate the corners of the shadow with reference to a point perpendicularly below the shade corners. The shadow boundaries can then be drawn in.

To use this graph, both the altitude and azimuth of the sun must be known. *Altitude* of the sun is the angle the sun makes with a plane through the horizon. *Azimuth* of the sun is the angle of the sun in a horizontal direction, measured in a clockwise direction from true north. Since both angles change continuously (except directly on the equator), values must be determined for the date, time of day, and latitude for which the shade is being designed. For a given location, it seems desirable to design (a) for the date and time of day when the solar radiation will be greatest (noon on June 22 in the northern hemisphere) or (b) for the time of year when the average air temperature is greatest and protection from the sun's rays most important, usually in August.

The altitude and azimuth angles may be found in several ways. For approximate determination, simple plastic protractors and slide rules are available. The U.S. Hydrographic Office and the United States Navy(6) publish tables of computed altitude and azimuth. The American Nautical Almanac(7), issued each year, gives precise values for sun declination. From these, altitude and azimuth may be computed for any latitude. A simple method of computation is well presented by Maas in *Architectural Record*(8).

The American Nautical Almanac gives the sun azimuth on September 1, 1948, at 11:00 a.m. solar time, as 148 deg 12 min east, and the altitude 61 deg 30 sec, (El Centro, Calif., 34 deg lat. n.). According to the graph in Fig. 3, these values for sun azimuth and altitude indicate the shadow of a shade 1 ft high to be 0.49 ft north and 0.29 ft west of the shade. Multiplying by 10 (the height of the shade) obtain the shadow of the hay shade as 4.9 ft north and 2.9 ft west of the shade. The diagram of Fig. 4 indicates not only the relative

positions of the shade and shadow but also the method of dividing the shadow and shade into sections for determining shape factors, the next step.

Determining Shape Factors. The shape factors of the five main sections of the surround (shadow, hot ground, under side of shade, horizon band, and unshaded cold sky) with respect to a sphere must be found. All of these factors together must total unity (1.00). Curves for the shape factors of plane areas with respect to a sphere, published by Mackey(9), are reproduced in Fig. 5.

These shape factors represent the percentage of the energy leaving the sphere which is intercepted by the surface in question. However, our problem is to determine what part of the energy leaving the plane surface is intercepted by the sphere. Moon(10) and others have shown, by the reciprocity theorum for fluxes, that the numerical figure for energy received by surface 1 from surface 2 is exactly the same as for the energy received by surface 2 from surface 1, when the radiosities are equal. Mackey's curves are therefore applicable for these computations.

A point 3 ft above the center of the shadow will be selected as the reference point at which the radiant heat load is desired. The shadow is divided into four rectangles of equal size, each 8 x 12 ft, with a common normal through one corner of each rectangle passing through the center of the small sphere. Then the ratio of L_1/D is 8/3 or 2⅔, and the ratio of L_2/D is 12/3, or 4. According to Mackey's chart (Fig. 5), the shape factor of such an area with respect to a sphere is 0.088. Since each of the 4 parts of the shadow is equal in size and is oriented in the same manner to the sphere, the shape factor of the shadow is four times the shape factor of one of the quarters, or 0.352. This value is entered in Table 2 as the shape factor of the shadow with respect to the sphere.

TABLE 2. VALUES FOR SHAPE FACTOR, RADIOSITY, AND RADIANT HEAT LOAD ON SMALL SPHERE, USED IN EXAMPLE OF COMPUTATION

Section of surround	Shape factor of section with respect to sphere	Radiosity, Btu/hr sq ft	Heat load or irradiation of sphere, Btu/hr/sq ft
Shadow	0.352	160	56.4
Hot ground	0.148	210	31.1
Horizon	0.087	205	17.8
Shade	0.200	176	35.2
Cold sky	0.213	133	28.4
	1.000		168.9

The shape factor of the hot ground with respect to the sphere should be determined next. As stated before, the shape factors of all sections of the surround must total 1.00. Similarly, those of the lower hemisphere must add up to 0.50. Since the lower hemisphere is made up of only the shadow and the hot ground, the shape factor of the hot ground with respect to the sphere can be found by subtraction to be 0.148. This also is entered in Table 2.

The upper hemisphere must be divided into three sections, the shape factors of which must add up to 0.50. The shape factor of the 10-deg zone of the sky just above the horizon can be found by geometry to be 0.087 from the theorem stating that the area of a zone is equal to the product of the altitude by the circumference of a great circle. Since the shape factor has been stated to be the fraction of the energy emitted by the reference sphere intercepted by the second object, that of the 10-deg zone is (for a sphere of unit diameter) by formula:

$$\text{Shape factor} = \frac{\text{Area of zone}}{\text{Area of sphere}} = \frac{2\pi R \times b}{4\pi R^2} = \frac{2\pi R^2 \sin\alpha}{4\pi R^2} = \frac{\sin\alpha}{2}$$

where R = radius of sphere
b = altitude of zone
α = angle the zone radius makes with diameter.

When α, or the zone angle, is 10 deg, the shape factor of the sphere with respect to the zone is then 0.087.

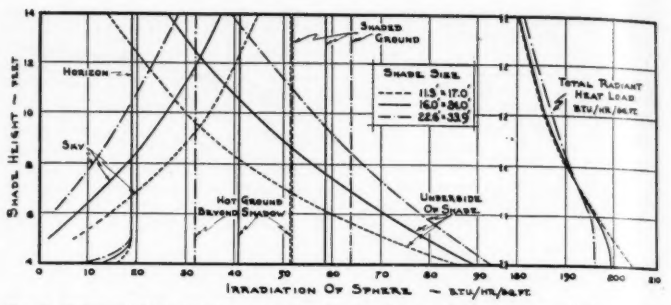

Fig. 6 Effect of shade height on irradiation of sphere 3 ft above center of shadow, for 3 sizes of corroded galvanized iron shades at El Centro, Calif. Amount of radiant energy received from each of 5 sections of surround and total radiant heat load are shown. Each shade has half the area of next largest size but proportions of all three are the same

The shape factor of the sphere with respect to the shade is a little more difficult to determine. Since the sphere has been postulated to be 3 ft above the ground, it is, of course, 7 ft below the shade, since the shade of the problem is 10 ft high. To orient the sphere on a line normal through one corner of a plane rectangle, so that Mackey's shape factor curves may be used, the area of the shade must be divided into rectangles of unequal size. Because the small sphere was also postulated to be directly over the center of the shadow, it cannot also be directly under the center of the shade, for the shadow was found to be 4.9 ft north and 2.9 ft west of the shade because of the position of the sun. However, the sphere will be directly below a point these same distances north and west of the center of the shade area. Therefore, as shown in Fig. 4, the four rectangles E, F, G, and H will be 7.1 x 10.9 ft, 7.1 x 5.1 ft, 16.9 x 5.1 ft, and 16.9 x 10.9 ft, respectively. The L/D ratios and partial shape factors from the curves may be tabulated as follows:

Rectangle	L_1/D	L_2/D	Shape factor
E	7.1/7	10.9/7	0.051
F	7.1/7	5.1/7	0.034
G	5.1/7	16.9/7	0.045
H	16.9/7	10.9/7	0.070
		Total	0.200

The total shape factor for the shade is 0.200.

As with the lower hemisphere, the total shape factor of the upper hemisphere with respect to the small sphere must be 0.50. We have determined that the factor for the horizon zone is 0.087 and for the shade is 0.200. The sum of these two, 0.287, subtracted from 0.50 leaves a shape factor for the cold sky of 0.213. The sum of the five shape factors is exactly 1.0.

The final step in the computations is to multiply the half-space rate of emission from each section of the surround by its respective shape factor with respect to the sphere. These multiplications have been tabulated in column 4 of Table 2, the sum or total radiant-heat load on the sphere from the surround being 168.9 Btu/hr/sq ft. Similarly, the total radiant-heat loads for the other examples in Table 1 have been calculated and are recorded therein.

INTERPRETATIONS

Study of the calculations just described will show that maximum lowering of the radiant heat load under a shade involves rebalancing the various radiating parts of the surround in such a way that the optimum or lowest value for a given environmental condition and shade material is obtained. Since conditions with regard to solar and sky radiation, air temperature, and other factors are never static, no one shade can be best for all conditions. However, an attempt will be made to point out, by the use of actual and, we believe, typical examples, some of the responses that can be expected from a shade.

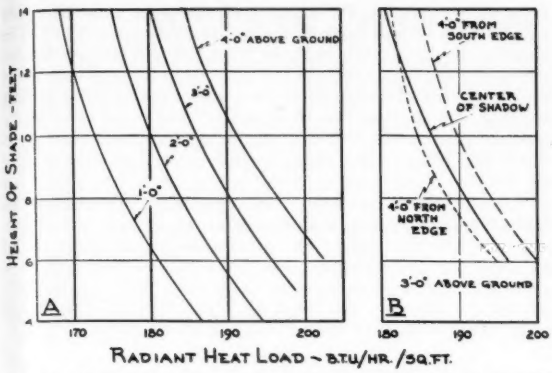

Fig. 7 Irradiation of reference sphere under 16 x 24-ft shade of example No. 6, Table 1. (A) Effect of shade height when sphere is 1, 2, 3 and 4 ft above center of shadow. (B) Effect of moving sphere to points 4 ft from north and south edges of shadow

Shade Orientation. In the hot sections of California, shades are commonly constructed with the long axis north and south, in order to keep the total irradiation of the ground under the shade sufficient to dry up the urine and feces and to promote sanitation. This practice increases slightly the radiant-heat load on the animals. The east-west orientation has the advantage that a greater proportion of the shadow lies to the north of the shade, providing possible exposure to the colder north sky for a larger number of cattle. Furthermore, the ground temperatures under the east-west shade may be a little lower because the ground is shaded for a greater part of the day.

Shade Size. Increasing the size of the shade varies the shape factor of the various sections of the surround with respect to the animal. As the shadow size increases, its shape factor increases and the hot ground factor decreases, thus resulting in a lowering of the radiation from the lower hemisphere. However, at the same time, the portion of cool sky radiating to the animal is being made smaller. The net result is that the belly of the animal is cooled and the back warmed, the total being about the same.

The effect of increasing the shade size is shown graphically in Fig. 6, where the radiant heat load on a sphere 3 ft above the center of the shadow is shown for 3 corroded galvanized iron shades ranging in height from 4 to 14 ft. The radiosities given for the 16 x 24-ft shade of example No. 6, Table 1, were used for the calculations and are believed to be typical for the area for this material. Curves are also indicated for shades half the size of the 16 x 24 ft shade, or 11.3 x 17.0 ft, and twice as large, or 22.6 x 33.9 ft. These proportions are the same.

Shade size had very little effect on the sphere irradiation in this case. Where aluminum or other material with a relatively high reflectivity for ground radiation was used, the outer areas of the shade had a higher radiosity than the more central areas, giving the larger shades the advantage of a greater proportion of low-radiosity area.

Shade Height. As the height of the shade is increased, the animals in the shadow become exposed to a larger percentage of the cool sky, tending to increase the cooling effect. Raising the shade does not alter the size of the shadow but the decrease in the temperature of the ground will be less because of the shadow's more rapid movement onto solar heated ground as the sun passes overhead. However, this difference in cooling upon arrival of the shadow may be nearly the same for different shade heights because of the rapid heat loss. This is shown by measurements made by a touch thermocouple under the galvanized iron shade of example No. 6 to determine the actual cooling rate of ground surface which is first heated by the sun's rays and then shaded. The data are given in Table 3.

The cooling during the first 5 min was rapid, averaging 36 F, or to within 12 deg of air temperature. In the next 5 min, the average temperature lowered only 2½ deg, and from then on, the cooling rate was still lower. The air velocity was low —between 4 and 6 mph. Higher velocity would have further increased the cooling rate.

Fig. 8 Globe thermometers being used to determine most comfortable areas under 12 x 16-ft aluminum shade at Davis, Calif.

The advantages of the higher shades are apparent, as was shown in Fig. 6. For instance, the heat load at the 3 ft level under a 16 x 24-ft shade 6 ft high is 196 Btu per hr per sq ft and only 183 Btu under a 12-ft shade the same size.

A field test on the effect of height of shade on cattle comfort was conducted with two 18 x 36-ft hay-covered shades at El Centro, one 7 ft high and the other 12 ft (Fig. 1). Both were located in the same corral, with 8 Hereford steers having access to each shade. Neither shade was more convenient to pasture, water, or feed than the other. The high shade was used almost exclusively; very seldom was an animal seen under the low one.

Practical cattlemen object to low shades because the moisture from urine and feces does not dry out as fast as under high ones. The concentration is in a smaller area and the sun does not shine on the ground for as long a period each day. However, aside from the sanitation angle, the moisture does serve to lower the ground temperature, by evaporation. Then, too, if high shades are used, trucks may be driven under them and range cattle may be worked by a man on a horse.

Animal Height and Location Under Shade. Varying the elevation at which the animal lives under the shade, will change the heat load. A hog or chicken, being closer to the cool shadow and farther away from the hot under side of the shade material, will receive a smaller amount of radiant energy, per unit of body surface under usual conditions of daytime radiation, than will larger and taller animals. Poultry confined in elevated cages in the California type of cage houses have been observed to be more uncomfortable than when on the ground under the same shade(11). As the irradiated object comes nearer the ground, the shape factor of the shadow with respect to the object increases, and the shape factor of the hot ground beyond decreases, thus resulting in a decrease of the lower hemisphere radiation. At the same time, the shape factor of the cold sky increases and the shape factor of the shade material decreases, resulting in a decrease of the upper hemisphere radiation also. This effect is shown in Fig. 7 for a small sphere located at the center of the shadow,

TABLE 3. TEMPERATURE OF SURFACE OF GROUND BEFORE AND AFTER SHADING, AT VARIOUS TIMES DURING DAY (AUGUST 9, 1948) UNDER GALVANIZED IRON SHADE, EL CENTRO, CALIF.

Amount of time shaded, min.	Time ground was first shaded			
	11:00 a.m.	12:00 m.	2:00 p.m.	4:00 p.m.
	Temperature of ground surface, deg F			
In sun	136	144	151	152
5	104	108	112	114
10	100	104	111	113
15	98	103	110	110
30	99	101	104	106
Air temperature (deg F) . .	92	95	98	104

1, 2, 3, and 4 ft above the ground. The irradiation of the sphere 1 ft above the ground averages about 20 Btu per hr per sq ft less than when 4 ft above the ground, the difference being more marked for the low than for the high shades.

Moving the sphere (or animal) away from the center of the shadow and nearer the hot unshaded ground will also change the shape factor "balance" and the resultant irradiation of the sphere. The irradiation for a sphere 3 ft above the ground and 4 ft from the north and south edges of the shadow are also shown in Fig. 7. These calculations are for example No. 6 of Table 1, the shade being oriented with the long axis north and south. The position near the north end receives slightly less energy than at the shadow center, and at the south end slightly more, on account of the changes in the shape-factor relationships. These results have been verified with globe thermometers on a full-size hog shade at Davis (Fig. 8).

Effect of Walls on Shades. A study was made of the effect of walls on the radiation heat load under a shade. Simultaneous radiometer and thermocouple observations were made at Davis on a 8 x 12-ft, three-sided shade 6 ft high, open on the north, having 2-in plank wood floor, 1-in wood walls, and double aluminum roof, and on a typical 12 x 16-ft flat aluminum shade 7 ft high. At noon, when the air temperature was 100 F and the air velocity 2 mph, the calculated heat load under the three-sided shade was 166 Btu per hr per sq ft, as compared to 172 Btu under the shade without walls. This was due mainly to cutting off radiation on three sides from the hot ground and horizon, and to a lower floor temperature. On the other hand, the walls also cut off a large part of the cool open sky, but this was not enough to counterbalance the ground-radiation benefits. The three-sided shade in this example had the disadvantage of a lower roof than the shade without walls. The same roof radiosities were used for both shades, to put them on a comparable basis. If the hot ground is replaced by pasture, reducing the radiosity of this part of the surround by about 85 Btu per hr per sq ft, the difference in heat loads between the two shades becomes negligible.

Trees for Shade. Trees have been suggested as being the "ideal" shade. Because of their irregular shape, their comparative value is difficult to measure with instruments. A limited number of observations at Davis indicate that their radiosity may be somewhat less than for a flat aluminum shade. A large black walnut tree averaged 138 Btu per sq ft when viewed from the shadow beneath it; a smaller catalpa tree averaged 141 Btu, and an aluminum shade, 170 Btu. At this time the air temperature was 83 F, with a slight breeze. One distinct advantage of trees is the fact that, because of their thickness or mass of leaves, their shadow is always larger than the vertical projected area, giving a larger low temperature ground area with a given exposure to cool sky than is possible with a thin shade. Disadvantages of trees are that in many cases the shadow is not solid because of openings between leaves, and that they do not fit into a practical farming practice where it is desired to rotate pastures frequently.

Improving Shades. The foregoing discussion indicates that the radiant-heat load on the animals can be decreased by lowering the radiosity of any one of the five elements of the surround, or by changing the proportions of the elements to which the animal is exposed so that the low radiating elements are increased. Again, using the galvanized iron shade (No. 6) of Table 1 as an example, the curve of Fig. 6 shows that merely raising the height from 10 ft to 14 ft will lower the radiation load from 186 Btu per hr per sq ft to 180 Btu, at noon.

Lowering the temperature of the ground in the immediate vicinity of the shade offers another opportunity to decrease the heat load. Midday observations at El Centro indicated that fescue pasture might be expected to average 85 Btu per hr per sq ft lower in radiosity than the hard ground in the corral. Calculations show that, if hot corral is replaced by fescue (lowering the radiosity from 275 to 190 Btu per hr per sq ft) the heat load at the shadow center will be reduced to 168 Btu per hr per sq ft. The heat load can be further reduced by covering the galvanized iron roof with an upper roof of hay, as was done in the shade of example No. 7. The shade radiosity is then reduced from the 200 Btu per hr per sq ft of shade No. 6 to the 168 Btu per hr per sq ft of shade No. 7, and the calculated heat load is reduced to 164. (Adding the hay will increase the thickness of shade and enlarge the shadow slightly too.) Thus, by raising the shade 4 ft, locating it in a pasture, and changing the material of construction, the heat load has been reduced a total of 22 Btu per hr per sq ft (from 186 to 164 Btu). This amounts to 1100 Btu per hr for an animal having a surface area of 50 sq ft exposed to radiation, or the equivalent of the hourly evaporation of about one pound of water from the lungs of the animal. It should be pointed out that each of these changes (especially the green pasture) will tend to lower the air temperature under the shade, further increasing livestock comfort.

SUMMARY

A method of obtaining the radiant heat load under thin flat shades by computing the irradiation on a reference sphere located under the shade is described. Typical values for radiosities for the various parts of the surround, from tests made on shades in the hot parts of California, are given for sample calculations. Curves are presented to show that, in areas with high solar radiation, high ground and air temperatures, and clear skies, the radiant heat loads under high shades are less than under low shades, and that the closer the animal comes to the ground the lower will be the heat load. Trees have the advantage of a shadow larger than their projected area, because of their depth. Little difference was found between east-west and north-south orientation. Methods of lowering the heat load by altering the shape factors and surround being found to be 168.9 Btu per hr per sq ft of radiosities of the surround, such as by the use of grass, wet roofs, etc., are suggested.

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The Engineer in Community Affairs

IN SUCH a complex and constantly changing national and world order as we recognize at the present time, there can be no excuse for any individual's failing to carry a reasonable share of the total community load. This is especially true of professional men and women, those upon whom the best we have in education has been lavished. This "community load" does not consist entirely of what we too frequently deride as politics. Indeed, the bulk of it has either nothing at all to do with politics, or at best is indirectly related to politics. I have in mind all those myriad enterprises in which men and women come together to accomplish purposes for mutual and public, as contrasted with strictly individual, benefits. They may have social, cultural, or humanitarian objectives, or a combination of all three.—Morris L. Cooke in *The Journal of Engineering Education* for October, 1950.

Window Insulation and Solar Orientation of Farm Structures

By D. C. Sprague and W. E. Eakin
MEMBER A.S.A.E. ASSOCIATE A.S.A.E.

POORLY functioning windows placed in farm structures with no thought of proper sun control have created a multitude of problems.

Evils of today's farm building windows are so numerous and efforts to solve these problems have been so futile that the tendency too often has been to reduce the window area or eliminate the openings entirely. Drafts from around the windows, heat losses, dust-collecting mullions and muntins and the frosted conditions of single-paned glass in winter have created such problems that many farm structures men have thrown up their hands in disgust. In spite of these temporary setbacks much progress is being made today in improving the function of windows in farm buildings and in determining how the glassed areas may be better used in temperature and moisture control and for improved health and environmental conditions.

Windows in farm buildings have not kept pace with new thinking in daylight engineering of homes, commercial and industrial buildings. Most farm building windows today are unchanged from a quarter to nearly a century ago.

A few years back there was a movement to larger glass areas in poultry and hog houses for a brief period but the heat losses, window condensation and drafts caused sickness and loss of stock that more than offset the advantages of larger windows. Today's farm building windows are a liability. They do a poor job of daylighting the interiors, are of little help in controlling the critical moisture problems, and are of no assistance in maintaining a moderate temperature in summer or winter.

Small panes of glass, with from four to nine lights to a wall opening, create a maintenance problem. The mullions and muntins are collectors of dust and dirt which in turn absorb moisture, causing the putty to break and the frames to deteriorate rapidly unless painted frequently. This moisture tends to weaken the structure and reduce the life of the building.

Although practically no work has been done to date to determine the germicidal effect of daylight passing through glass in farm structures, there is proof available of such germicidal benefits in other types of structures. Dr. Isadore Rosenfield, noted architect and hospital consultant, writes that "light from grey skies, even though filtered through two thicknesses of ordinary glass, is still germicidal." He also points out that sunlight is faster in its effectiveness than light reflected from the sky or clouds.

A few livestock and poultry authorities have recognized the value of sunlight and daylight in farm buildings. "An essential to the best success of a chicken house is plenty of sunshine," says Dr. L. E. Card of the University of Illinois in recommending windows to the south in poultry houses. "The hens like it, and the sunshine helps to moderate low winter temperatures and to keep the house dry. Sunshine helps to prevent disease as well. It is one of the most effective germicides," Dr. Card adds.

Artificial breeding association experiences with low conception rates among cows in poorly daylighted barns support the theory of Dr. Glenn Salisbury also of the University of Illinois "that light influences reproductive functions in cattle by its action on the pituitary through the eye and the optic nerve."

Other observations show additional benefits from a well-daylighted and insulated building including improved comfort for the worker, better sanitary conditions and control of environment and, according to some veterinarians and livestock specialists, improved animal fertility.

Recognizing the evils in present farm building windows and the need to improve the window role in these structures, Libbey-Owens-Ford Glass Company has become interested in stimulating advanced thinking on functions of windows on

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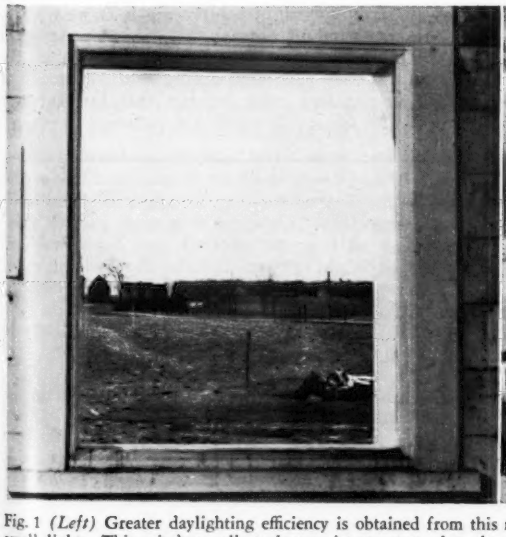


Fig. 1 *(Left)* Greater daylighting efficiency is obtained from this modern insulated window with one large pane of glass instead of the conventional small lights. This window collects less moisture, stays clean longer, and lets in more daylight through the same wall opening than other type windows • Fig. 2 *(Right)* This modern dairy barn on the Nasco farm near Ft. Atkinson, Wis., was designed by S. A. Witzel of the University of Wisconsin to take advantage of solar heat. The milkroom window is to the left, milking room windows are in the center, and the window to the right faces the maternity pens

the farm. With a better knowledge of the proper use of glass for daylighting and the application of solar energy in moisture control and heating in farm buildings it is believed that this product will contribute to greater efficiency in agricultural production. The application of insulated windows and the possibilities of solar heat to farm structures is being worked out cooperatively by the company with several of the state agricultural colleges and leaders in the farm building field.

The value of insulated windows long has been recognized by many agricultural leaders who in the past have recommended storm sash. However, rather than to go to the trouble of putting up and taking down storm sash each year most farmers have gotten along with single-glazed windows.

Because of the cost factor, little thought had been given until now to the use of insulating glass in farm structures, although practically every piece of machinery or other improvement on the farm when first introduced was felt to be too expensive to be practical.

Libbey-Owens-Ford insulating glass — known by the commercial name "Thermopane"—basically is two lights of glass with a pocket of dry air sealed in by a metal-to-glass bond. With the moisture taken out of this air pocket, it serves as an insulating unit that will not condense between the two lights of glass. Perfected primarily for the home, this insulating glass normally is made with polished plate glass for clearer vision.

For farm buildings the same serviceable unit may be made with less expensive window glass in the smaller sizes and with heavier sheet glass, 3/16 in thick with a ½-in air space for window openings up to 42 x 72 in. Several standard sizes in this thicker glass soon will be available for farm requirements. The U value, or heat transmission factor, of this product is 0.58 as compared to 1.16 for a single plane of glass.

Solar Heat for Farm Buildings. Insulated windows properly oriented for sun control make it possible to keep buildings warmer in winter and cooler in summer. Likewise such windows help to make an insulating job complete, maintain a higher temperature in winter and by so doing help to increase the efficiency of the ventilating system in reducing the moisture problem.

The solar-heat principle which has spread so rapidly in the home field now may be applied to farm buildings. There are four fundamental factors of solar design: (a) window orientation to face south to obtain the heating benefits of solar radiation in winter, (b) larger windows which are necessary to provide proper entry of solar radiant energy in winter months, (c) insulated glass to cut down on the heat loss, and (d) sun control which is achieved by the use of permanent or temporary roof overhangs, visors or other means of controlling shadow areas on the windows so that sunlight can enter during cold weather and be shut out during the hot summer months.

Previously farm building windows have been placed on the east and west exposures in many instances in the belief that the east openings permit entry of the morning sun and the west windows the afternoon sun. This is true especially in the late spring, summer and early fall when the heat rays of the sun are undesirable. In the winter when solar heat is needed little can enter east or west windows because of the position of the sun being low in the southern sky. South windows permit entry of the sun in winter, in early spring and late fall when the warmth of the sun is needed to help heat the interior.

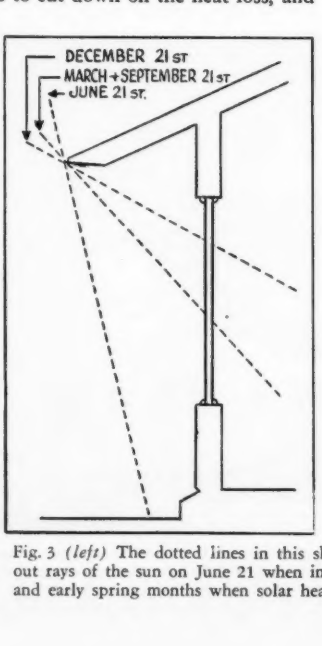


Fig. 3 *(left)* The dotted lines in this sketch show how roof overhang may be used above south windows to shade out rays of the sun on June 21 when interiors should be kept cooler, yet permit their entry during the fall, winter, and early spring months when solar heat is desired • Fig. 4 *(right)* Position of the sun at noon at Ames, Iowa, on June 21 and December 21

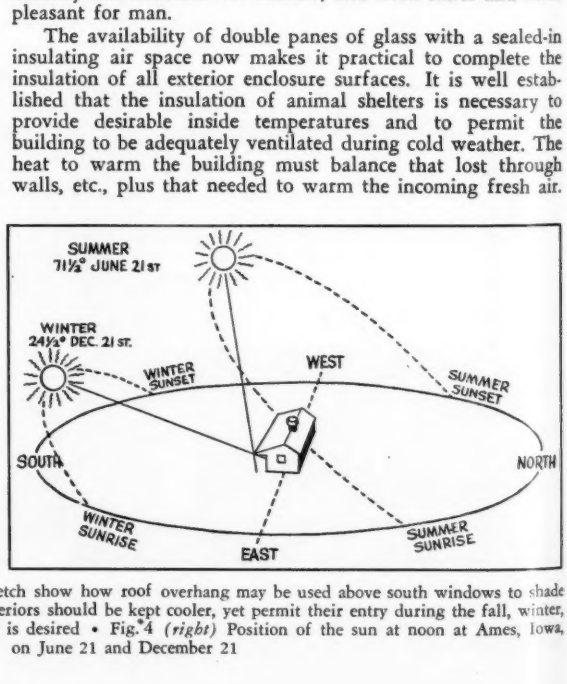
Whether the window areas be north and south, or east and west, use of insulated glass will increase their daylighting efficiency, help the ventilating system, cut down drafts in the window area and make it possible to better control the moisture problem and maintain a more uniform temperature. This in turn contributes to better health for the livestock and poultry, maintenance of peak production over a longer period, better working conditions for the attendant, and longer life for the building.

With the trend to specialization in livestock and poultry production, as indicated by the pig nursery idea, construction of poultry buildings housing up to 60,000 birds under one roof and the labor-saving methods introduced such as self-feeders, gutter cleaners, the milking parlor and milkhouse, it is becoming more important than ever to have the ultimate in improved sanitary and environmental conditions. With greater investments in livestock and buildings these interests must be safeguarded and maintenance problems reduced. Solar heat may be used to intermittently condition the interiors in reducing the moisture problem, and electric or other automatically controlled heat may be used for additional warmth in winter months.

We believe windows of tomorrow in at least the colder portions of the country will be of insulated glass. Many will be in fixed frames or a combination of fixed and ventilating sash. Windows in most cases will be larger and will run horizontal rather than vertical and will be placed higher on the wall. For greater efficiency windows will be in north and south walls with the greatest number on the south and enough on the north to provide balanced lighting.

Advantages of Insulating-Type Windows. From an engineering standpoint properly planned windows can contribute to the benefits obtained from remodeled and new farm buildings in better building performance. Unfortunately most farm building windows today are responsible for drafts, ventilation troubles, frosty, wet, rotting sash and sills, dark work areas, and insanitary barns and milkhouses. This need not be true. Farm building windows can be planned to simplify building construction and decrease maintenance problems. Properly planned windows can make shelter building conditions more sanitary and healthful for animals, and work easier and more pleasant for man.

The availability of double panes of glass with a sealed-in insulating air space now makes it practical to complete the insulation of all exterior enclosure surfaces. It is well established that the insulation of animal shelters is necessary to provide desirable inside temperatures and to permit the building to be adequately ventilated during cold weather. The heat to warm the building must balance that lost through walls, etc., plus that needed to warm the incoming fresh air.



Any decrease in heat loss, or increase in available heat, will permit a greater rate of air change or a higher inside temperature for a given outside condition. The use of insulating windows affects this heat balance to the same extent as would the addition of any other kind of insulation which would reduce the heat loss the same amount.

However, insulating windows contribute much more to environment within the building than does a comparable amount of structural insulation. The transmission of daylight is the principal function of a window. Under conditions which exist in livestock and poultry shelter, insulating windows often are considerably more efficient in letting daylight and sunshine into the building than ordinary single-glazed windows. Observations of installations made for the purpose of comparing the performance of insulating windows with that of old-fashioned windows, both used under the same conditions, have shown that insulated windows gather dirt less rapidly, stay freer of condensation, and are much less apt to frost over than ordinary windows including those protected with storm sash. This is to be expected as the inside surface temperature of an insulating window more nearly approaches the inside air temperature than that of a single pane of glass. Thus the inside surface of an insulating window is less apt to reach the dew point and condense moisture. Also, the warmer inside surface temperature produces less convection current, thus less dirt is carried to the window to coat it. Too, dirt adheres much less to a dry window than a wet one. The accumulation of moisture and dirt on the glass surfaces in the space between the panes decreases the efficiency of the storm sash, especially on cold days. The sealed space filled with dehydrated air in the insulating-type window prevents this difficulty. More objective data on the comparative performance of these windows will be forthcoming from studies under way at the Universities of Wisconsin, Massachusetts, and Cornell.

INSULATING-TYPE WINDOWS IMPROVE DAYLIGHTING

Insulating-type windows, therefore, make better daylighting of animal shelters possible. They let in more light per square foot of window area under actual use than do ordinary windows because they stay cleaner. Also, more window area can be used without increasing the heat loss when ordinary windows are replaced. At the same time, drafts caused by cold window surfaces are minimized.

Increased Effectiveness of Windows. The effective light-transmitting area of a window opening may be increased as much as 50 per cent in some cases by using a single pane of glass in the opening rather than the conventional multiple-light sash. For example, the popular 22 x 29-in four-light barn sash fits into an opening having an area of 638 sq in. It provides an unobstructed glass area of about 400 sq in. Glass area more nearly approaches that of the wall opening when a single pane is secured in the opening by stops or narrow frame.

Large window openings admit more daylight and sunshine into a building than do an equal area of small ones, especially those in thick walls. In general the amount of light reflected from the sky through a window is proportional to the area of the sky which may be seen through the wall opening. The ratio of the area blocked out by jambs to the area of the window, increases as the wall thickness increases. For a given wall thickness it decreases as the size of the window is increased. Likewise, the effective area through which the direct rays of the sun may enter through a wall opening is affected by the thickness of the wall and the size of the wall opening. When the sun is not perpendicular to the face of the window, increasing the size of the wall opening also increases the per cent of effective window area. For example, consider the sun to be at an angle of 45 deg to the face of a window in a wall 1 ft thick. The width of the beam of sunshine entering window openings 2 ft and 4 ft wide would be, respectively, 0.707 ft and 2.12 ft. Thus, for equivalent sunshine, one window 4 ft wide is equal to three windows 2 ft wide. Therefore, with large panes of sheet glass of suitable strength available, the use of larger windows and window lights seems very logical.

Fixed Windows and Ventilation. The second function of a window has been to provide a means of ventilation. Farmers know the hazards of window ventilation and the attention it requires. Electric service is now made available to practically all farms, and with it automatic ventilation. Considering that one watt of electrical energy input will circulate as much as 20 cfm of air through a building, and that only about 40 to 200 cfm is needed per cow during the time they are stabled, the possibilities of automatic ventilation become apparent. The development of ventilating systems not dependent upon windows is well under way. Some new barns are being built with all windows fixed in place.

Data reported by Harold V. Walton in a graduate school thesis, "Air Flow Characteristics of Fresh Air Inlets Used in Animal Shelters", agricultural engineering department, Pennsylvania State College, are helpful in explaining the difficulties encountered in window ventilation. The operating-pressure differential found to exist between the inside and outside of many exhaust-fan-ventilated dairy barns is about 0.03 in w.g. (water gage), when there is no appreciable outside air movement. These data also show that, when a 34-in tilt-in window is opened to serve as a fresh air inlet, it will admit about 170 cfm of air when the difference between inside and outside pressures is 0.03 in w.g.

WIND CAUSES BOTH POSITIVE AND NEGATIVE PRESSURES

It is recognized that wind will cause both positive and negative pressures about a barn, the amount of pressure change at any location depending upon wind velocity, its direction and other factors. Some observations have shown that gusts of wind frequently encountered may increase the effective pressure differential across an inlet to the equivalent of 0.2 in w.g. and more, or they may even create a negative pressure. Data show that when the static-pressure differential across the window is increased to 0.2 in w.g., the same opening will admit 470 cfm, or 300 cfm more. The same window when opened 6 in was found to admit 590 cfm under a pressure differential of 0.03 in w.g. Thus it can be seen that window inlets require the attention of the operator to adjust them as weather conditions change.

The further study of Mr. Walton's thesis shows that the performance of all unrestricted inlets is about the same. One especially designed restricted type of inlet maintained constant-volume air flow through a varying pressure differential of from 0.04 to 0.3 in w.g. which was the limit of the test. This type of fresh-air inlet may greatly improve the ventilation of farm buildings. In order to overcome the difficulties of admitting air uniformly through inlets into a building, thought is being given to forcing the air in and allowing it to escape through outlets. One company is testing the performance of heat-exchange equipment which will be completely automatic in operation. The trend in the development of ventilation equipment is to eliminate the use of the window.

The possibilities of fixed insulating windows in poultry houses is being explored. W. C. Krueger, extension agricultural engineer, Rutgers University, has under his observation a laying house for 2000 birds in which there are 52 fixed windows each having 27½ x 51 in of insulating glass. Air is forced into this house and distributed by means of a large duct located at the ceiling. The results obtained in maintaining desirable house temperatures and dry litter during the past winter and spring were very satisfactory. The effectiveness of summer temperature control in the house has yet to be observed.

The warm weather ventilation of buildings with non-opening windows which we have observed, has been facilitated by the opening of doors. The results during winter and spring weather obtained in barns, milking parlors and milkhouses have been very satisfactory, and are judged to be practical and superior to window ventilation.

The success with which desirable temperature may be maintained in these buildings during summer will be affected greatly by how well the windows are insulated, how they are orientated, and possibly how they are shaded.

Window Orientation and Control of Solar Energy. The position of windows greatly affects the amount of solar energy

that will pass through them. The more nearly the window faces perpendicular to the sun's rays, the greater will be the heat input. In the summer at our latitudes the sun rises north of east and sets to the north of west. At this period of the year east and west windows may be objectionable because in the early forenoon and late afternoon unwanted solar energy enters the building through them. West windows are most troublesome in this respect.

The sun's rays strike south windows during summer only when the sun is high in the sky. Because of this the rays impinge at such an angle that much of the energy is reflected and does not pass through the glass. When desired, all the direct rays of the sun may be prevented from striking a south window by shading it with a simple roof overhang. On the other hand, it is difficult and often impractical to prevent the sun from entering the east and west windows of farm buildings during summer. Trees, outside blinds or low awnings must be used because the sun will shine beneath a simple roof overhang during the early morning and late afternoon. Very little solar energy will enter north windows.

ROOF OVERHANG TO SHADE SOUTH WINDOWS

The roof overhang or projection needed to shade south windows during summer should not exclude the winter sunshine. To properly design the overhang it is necessary to know the minimum profile angle of the shadow cast by the overhang at the time the window is to be entirely shaded, and also the maximum profile angle during the time it is desired to expose all window to the sun. Of course, there are practical limits to the lengths of time that the window can be entirely shaded or exposed by use of a non-adjustable overhang. It seems to be common practice, in the case of solar-type dwellings, to design the overhang to completely shade the window from the end of the heating season until about the beginning of the next, and to provide for irradiation of the entire glass area of the window by the sun on December 21. From December 21 to the date selected for complete shading, the amount of direct radiation through the window decreases each day, and of course it increases again in the fall to December 21.

In order to design a fixed overhang for a window facing south, data must be available which will give the elevation of the sun at high noon at the given latitude on the days selected for complete shading and exposure. Graphic means of determining the position of the edge of the overhang probably is easiest. This is accomplished by first drawing to scale a section of the wall and window. A line is then drawn from the bottom of the window at an angle with the horizontal equal to the elevation of the sun on the day the window is to be shaded. Another line is made from the top of the window at an angle equal to the elevation of the sun on the day the window is to be entirely exposed. The lines are extended until they intersect and the point thus formed marks the edge of the overhang. A line drawn horizontally from this point to intersect the plane of the window represents the length of the overhang. The height of the overhang is represented by the distance from this line to the top of the window. Actual dimensions are determined by the scale of the section drawing.

Performance of Insulating Windows. To date insufficient experience can be called upon to determine the necessity and practicality of overhangs for farm building windows. Overhangs for south windows planned to take advantage of solar heat will be used for observation purposes by several of the agricultural colleges on several structures now under construction or contemplated. These include a hog house more than 100 ft long with 32 windows of insulating glass, 36 x 66 in, at the University of Minnesota's Rosemount branch experiment station and several milkhouses and milking rooms in Pennsylvania and Maryland. Solar-type poultry houses with overhangs for the south windows are planned in Illinois and at Pennsylvania State College.

Milkhouses and milking rooms on the farms of Hugh Highsmith, Fort Atkinson, Wis., and the late H. E. Babcock, Ithaca, N. Y., each with large insulating-type south windows and no overhangs, were not found to be objectionably warm last summer, according to the farm managers.

The effects of wintertime solar heating were demonstrated by these installations. Solar heat helped noticeably in drying the interiors and warming them during the day. It was found that floors could be dried quickly by properly ventilating during the middle of the day after they had been scrubbed. On most days solar heat was sufficient to make inside temperatures comfortable during evening choretime. During colder weather supplemental heat was found desirable to prevent freezing on very cloudy days and at night, and especially to warm the milking room for the early morning milking.

An outstanding example of how a critical moisture situation in a dairy barn was corrected by increasing the window area with insulating glass and changing the ventilating system is the Hokenson barn under a joint study by Max La Rock, University of Wisconsin, and Robert Yeck, U.S. Department of Agriculture. This was a typical bank-type dairy barn, poorly lighted and ventilated. The stable is 36 ft wide, 84 ft long, with an 8½-ft ceiling, and houses 40 cows facing out in two rows of stanchions. In less than 10 years, rotting of the south wall made extensive repairs imperative. In repairing and remodeling the structure 160 sq ft of insulating glass was installed in the south wall, and electric ventilation replaced the gravity system.

In addition to 14 units of insulating glass, 44 x 40 in, on the south wall used in the study, 8 single-paned windows with three lights, 14 x 16 in, were left in the north wall over the bank and 3 windows with six lights each, 10 x 16 in, are at each end. The ventilating fans exhaust about 4,000 cfm of air.

AMOUNT OF GLASS AREA FOR SATISFACTORY DAYLIGHTING

Observations made with all but the south windows covered indicated that 4 sq ft of glass area per cow located in the south wall provided satisfactory daylighting of this stable during most of the hours of daylight, but that in the early morning and late afternoon the north feed alley, especially at the end of the barn facing the sun, was not nearly as well lighted as the other areas. Also, it was observed that uncovering the windows at the east and west ends substantially increased the light intensity along the entire north feed alley during the early morning and late afternoon. In cases where north windows are difficult to provide, a limited area of east and west windows may be desirable in spite of their high solar-heat gain during summer.

The total area of insulated and ordinary windows in this barn equals 5¾ sq ft per cow. With the thermostatically controlled electric ventilation, a stable temperature of about 58 F and a relative humidity of about 55 per cent was maintained during the winter. This indicates the effectiveness of the over-all insulation of the barn as the relative humidity averaged 10 to 14 per cent lower than that ordinarily encountered in dairy barns. Undoubtedly the solar energy entering through the south windows contributed to maintaining a low relative humidity in the stable during the daytime.

Methods of Installing Insulating Glass. Most insulating glass is being installed in farm buildings as fixed panes held in place by stops nailed to the jambs, head and sill, in the window openings. One barn equipment manufacturer has developed a steel sash for both ventilating and fixed windows of insulating glass. These may be installed individually or in combinations in window openings in either concrete masonry or frame construction.

Another manufacturer has developed a ventilating sash for insulating glass which is designed for use between studs placed 24 in on center, and provides a light 16 in high. When placed in the walls of a stanchion barn an area of 4 sq ft of glass is provided per cow.

Solar Designs Now Possible. The utilization of solar energy as a source of heat for farm buildings is not a new idea. The need for heat to dry the interiors of animal shelters and to maintain comfortable inside temperatures during winter has long been recognized. Little use has been made of this natural resource to heat *(Continued on page 613)*

Results of Studies of the Failure of Plain Concrete Irrigation Pipe Systems

By Arthur F. Pillsbury
MEMBER A.S.A.E.

PLAIN (non-reinforced) concrete irrigation pipe systems for the distribution of water on surface-irrigated farms have been used for many years in the south coastal basin of California and elsewhere. Such systems permit easy control of the water, almost complete prevention of seepage and evaporation, distribution without appreciable loss of land, and are quite permanent. Maintenance problems are or should be slight, and the systems are economically feasible on most farms. Most systems are used year after year without giving trouble, but there have always been some failures, and investigations pointing the way toward the minimizing of those failures are reported herein.

Description of Systems. Hydrostatic pressures are limited to about 25 ft of water, but seldom exceed 10 or 12 ft. Prefabricated sections generally are in 2½ to 3-ft lengths with tongue-and-groove joints which are mortared together. The inside diameters of the standard sizes are 6, 8, 10, 12, 14, 16, 18, 20 and 24 in (some manufacturers use 15 and 21-in sizes instead of the 14, 16, and 20). Use of the 20 to 24-in sizes is less common and involves more hazard of breakage than the smaller sizes.

Usual distribution is from or near the high corner of the farm. Pipes, laid vertically on a freshly poured concrete base, form *stands*. Such stands may have diameters of 30 to 42 in. The stands serve in one or more of the following capacities: (a) regulating structures to prevent high hydrostatic pressure; (b) vents to release air from the lines, especially at high points; (c) diversion structures, with gate valves mortared to the pipe lines radiating out from the stands; (d) settling basins and sand traps; (e) surge chambers; (f) metering structures. Where limitation on the function of a given stand permits, its diameter may be cut down to the diameter of the pipe, but preferably should not be smaller.

Hydrants of many types are placed on the tops of concrete pipe risers. The hydrant valves usually are horizontal disks with a ring of packing material around near the periphery. The disk screws down onto a machined ring seat which is mortared to the riser, and to which is fastened the spider on which the disk screws up or down. For flood irrigation these are usually called alfalfa valves and are flush with the ground surface. For furrow irrigation the valves, called orchard valves, distribute into large diameter vertical pots. Such pots have a series of sheet metal slide gates around these sides, one to four inches above ground surface, through which flow into individual furrows is regulated. A variation of the latter utilizes a steel pipe riser with a globe valve at the top discharging into sheet metal pipes 6 to 15 ft long, on swivels and with sheet metal gates at regular intervals. Thus these arms can be laid across the furrows, discharging directly into them without handwork, and can be raised out of the way, chained to a post when not in use. Closed-pot hydrants with the top of the pot sealed over are also used where grades are flat and pressures low. They are more difficult to regulate, but have the advantage of keeping out leaves which may plug the slide gates, and do not require orchard valves.

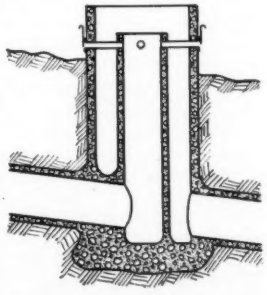


Fig. 1 Typical overflow-pot hydrant adapted to a low-flow furrow irrigation where pipe line is on a relatively steep slope

Where the pipe line grade is such as to cause appreciable variation in pressure at the hydrants, or such that water may not at some points be of adequate pressure to flow from the hydrants, certain devices must be utilized to give frequent pressure regulation, as follows:

Overflow-pot hydrants, Fig. 1, are especially adaptable to low-flow furrow irrigation on steep slopes. Often the risers are reversed—inflow on outside—but this results in air being entrained in the overflow water and causing operating difficulties downstream.

Overflow stands, Fig. 2, are common with larger flows. The by-pass gate valve in the A type is practically a necessity in many installations because of the large amounts of air entrained in the small downpour section, with resultant surging. Where the gate valve is not necessary for other reasons, the B type with a large downpour cross section is preferable because of less air entrainment.

Float-valve stands, Fig. 3, have many advantages, especially in simplicity of regulation. There are at least two types of float valves on the market which appear to give good service, and their use is extending quite rapidly. With float valves, whenever a hydrant opening is changed, that change in the flow is automatically corrected all the way upstream in a pipe line without appreciable changes in pressure at other hydrants. A float-valve system has the characteristics of a semiclosed rather than of an open system.

Types of Failure: Most failures of these systems fall into the following categories:

1 Development of longitudinal cracks in the pipe, principally in the top and bottom, usually within a few days or weeks after laying

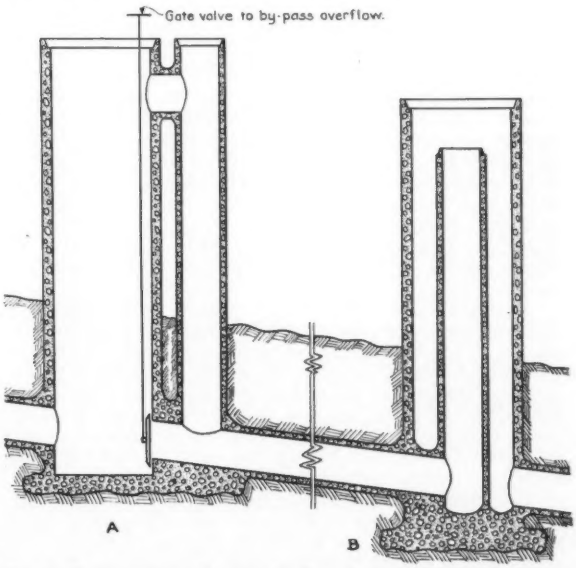


Fig. 2 Two typical overflow stands. Type A is most common. Type B should give less air entrainment with overflow

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AUTHOR'S NOTE: The author gratefully acknowledges the cooperation and advice of personnel from the U.S. Bureau of Reclamation, Portland Cement Association, California Associated Concrete Pipe Manufacturers, and several individual manufacturers.

2 Telescoping of sections together
3 Pushing of the pipe into stands
4 Development of circumferential cracks
5 Deterioration of the concrete.

The first four types of failure are closely related and will be discussed together.

Deterioration of the Concrete. The causes of concrete deterioration were investigated sometime ago(1)*. Principal deterioration of concrete irrigation pipe has been caused by one commercial inorganic fertilizer—ammonium sulfate. If this fertilizer must be applied in the water before going through pipe lines, extreme care must be exercised. It is recommended that concentrations never exceed about 0.1 per cent and that the lines be flushed out immediately afterwards. If such precautions are exercised, danger of concrete deterioration is remote. With high concentrations, pipe lines may fail in a matter of months.

The only other commercial fertilizer found to cause any deterioration was ammonium nitrate. With this the effect was small, and use of concentrations up to 1 per cent, with flushing of the lines afterwards, should cause no trouble.

Soil amendments often contain sulfates, so are suspect of being deleterious to concrete pipe when applied through the medium of the water. For a few years some growers have been applying gypsum in this manner with no reported difficulties as yet. Since the solubility of gypsum is low, this is not surprising. Whether or not eventual trouble may be experienced is unknown to the author. Other soil amendments have given trouble.

Water Hammer. No investigations were made of water hammer caused by surging with air entrainment because the investigations of Roberson(2) and the U. S. Bureau of Reclamation indicate that significantly high pressures did not result therefrom. The data of the Bureau of Reclamation has not been published.

Wetting Expansion. Concrete expands with wetting, and contracts on drying. Smith(3) in 1917 observed wetting expansion and related it to failure of concrete pipe. Stanley(4) also observed wetting expansion in pipe. Matson(5) measured unrestrained wetting expansion. Circumferential stresses can be set up in pipe from differences in moisture through the pipe wall. Stresses can also be set up because of differences as between the moisture content of the invert and of the crown. These would account for the characteristic longitudinal rips in crown and invert, and for the larger sizes to be more susceptible to failure. By the nature of the systems, longitudinal expansion is completely restrained. This results in a characteristic Poisson's ratio lateral strain, but no significant lateral stress.

Tests have shown (6) that failure from excessive axial restraint takes the form of axial cracks. This indicates that the failure is a Poisson's ratio strain failure. Subsequent tests showed the stresses from differential wetting of the shell to be additive to this. With restraint, axial stress was shown to build up to a near maximum in 2 weeks when pipes were wetted. With the tests run, this maximum stress has ranged from 700 to almost 1200 psi, and, in some cases, stress has decreased somewhat, probably due to creep, after 3 months or so. Higher cement content pipe produced somewhat high axial stresses.

Pipe has failed without water actually being placed in it. This appeared to be related to the absorption of moisture from moist soil, and considering laying practices usually employed, the trench bottom soil might well have a higher moisture content than the backfill soil around the rest of the pipe. Therefore, tests have been made on the effect of humidity on expansion. At a constant temperature and with relative humidity varied in the range 33 to 100 per cent, concrete pipe was found to respond rapidly to changes in that humidity(6).

Soil, once wet, should not dry out to less than the permanent wilting percentage (7, 8) except near the surface, and so the relative humidity of the soil air adjacent to the pipe extrados should always be in the range 98 to 100 per cent(9).

* Numbers in parentheses refer to the appended references.

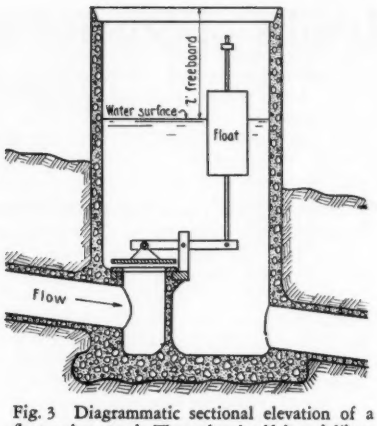

Fig. 3 Diagrammatic sectional elevation of a float valve stand. The valve itself has deliberately been made unlike any of the types in use in southern California

In such an environment the data indicate that the pipe will undergo considerable expansion.

Thus it is indicated that, once a pipe line is placed and after the backfill soil has been moistened (if dry), at least the extrados of the pipe will always be under humid influences and dry contraction will not take place. Further tests, though, showed that drying contraction of the extrados does actually take place if there is somewhat moist soil (above permanent wilting percentage) against the extrados and a draft of rather dry air is circulated through the pipe. This must result from (a) diffusion of air through the pipe walls or (b) absorption of moisture vapor by the concrete from the soil air.

These factors are important because lateral strain from Poisson's ratio axial restraint is not sufficient in itself to cause longitudinal ripping. Ripping occurs only when this strain is in combination with circumferential stresses from differential wetting of the shell. These latter will be minimized if differential wetting is eliminated as much as possible—by using moist soil for the original backfill and by preventing a drying circulation of air through the pipe.

There remains one question: What effect on expansion has the capillary movement of moisture upward from the water surface in a pipe partially filled with water? Tests run at constant temperature indicated no expansion at distances of 1 in or more above such a water surface in a period of 20 days. Thus, the complete filling of a pipe line with water as soon as feasible after laying is desirable as well as the preventing of air circulation through the line.

Thermal Contraction. Joint cracks occur, and leakage results, in the field when extremely cold water is run through the lines. This is simply a result of thermal contraction of the concrete. Partial drying out of the pipe with a draft of air through it may well contribute to the leakage. When the water may vary considerably in temperatures, the main protection against such leakage is the axial stress resulting from wetting a restrained pipe. It would appear, with many installations, that the greatest axial stress possible is desirable to prevent contraction leaks.

Discussion. Higher strength pipe appears to result in less creep and greater axial stresses, and thus more resistance to low-temperature difficulties. It appears that there should be constant effort toward making the concrete denser and stronger. Certainly the unfortunate fact that many manufacturers produce pipe which will not fully pass ASTM specification C-118-39 should not lead to a weakening of those specifications. If anything is needed, it is that those specifications should be made even more rigid, and that they should be enforced by farmers more rigorously.

High cement content pipe creates higher longitudinal stress than similar low cement content pipe. In the tests herein mentioned, with the pipe dry, the axial stress at which axial cracks became visible was also higher. Thus the evidence is not clear

whether or not a rich mix is detrimental as far as failure by ripping is concerned. However, there are two factors which indicate the desirability of placing a limit on cement content, to wit: (a) It is probable that increases in cement content of mix cause an increase in the thermal expansion coefficient (10), thus the value of any increase in axial compression below that causing rips is negated; (b) limiting cement content is a means of requiring manufacturers to utilize better aggregate grading and greater compaction to produce pipe passing specifications. The practices of some manufacturers in this regard leave much to be desired.

RECOMMENDATIONS

1 There is every indication that plain concrete irrigation pipe should be fabricated to produce a product of high strength and density. As well as protecting the pipe from deterioration, such qualities would also help maintain a high axial compressive stress in the line which would serve to minimize any contraction leaks when cold water is run through the lines in winter and spring. The ASTM Specifications C118-39 should be rigidly adhered to with an additional limit on the richness of mix of probably 1:4 or 1:4½.

2 The need for curing the pipe after fabrication has been given attention in the past. Except for the case of concrete draintile, the need for thorough drying of concrete pipe after curing has not been considered. Such drying offers the best possible method of providing for insurance against cold water contraction leaks. Dry storage for a month after curing might be highly desirable.

3 Longitudinal compression, although essential insurance against contraction leaks, has often caused failure by ripping. There are no indications that ripping would occur if it were not for the additive circumferential strains resulting from differential moisture absorption by the pipe, consisting of variations through the shell and/or variations as between invert and crown. Limited use of expansion joints may prevent ripping. A better practice would seem to be that of a few installers who irrigate along the trench site just prior to trenching. Thus, if installation and initial backfill are reasonably prompt, the initial backfill should be moist. As disclosed by these investigations, this would result in slow wetting expansion all around the pipe, minimizing circumferential strains from differential wetting, and the free end of the pipe could move slightly relieving any excessive longitudinal compression. Skin friction should be great enough, and wetting expansion slow enough to prevent the relieving of much axial compression, presuming a normal rate of laying and presuming that the initial backfill is placed 2 to 5 lengths behind laying. If it should be impractical to have a slightly moist initial backfill, a light fine spray of water could be directed onto the pipe and backfill, as the initial backfill is being placed. If the weather is humid at the time of laying and for a few days before neither of these precautions should be necessary.

4 Because of the apparent drying of the extrados of good quality pipe when there is moist soil against the extrados, and when a draft of air is directed through the pipe, it is recommended that circulation of air through lines be minimized. Where grades are flat, design to cause water to stand in lines when not in use is simple. On steeper grades several methods of minimizing air circulation can be used. One would be to have a float valve controlled (semi-closed) system. Another would be to cover stands and to keep all gates and hydrants closed. Also, the designing of open overflow stand systems to keep a pocket of water upstream from each such stand would help.

5 Some systems are installed with the pipe being placed first, and at some later date stands being constructed and the loose pipe ends then tied into them. Thus excessive pre-expansion of the pipe near each stand could be expected. It is recommended that stands be constructed first, and the pipe be tied into them as it is being laid. Similarly, concrete anchors should be poured around pipe lines at any break in grade or alignment, and at any point where there are loose ends for any appreciable period of time.

6 Concrete pipe should be protected from chemical deterioration. So far as is known, the only such deterioration that has occurred in irrigation pipe lines has resulted from the practice of adding unwisely high concentrations of certain commercial fertilizers and soil amendments to water that is to flow through the lines. In this regard it is recommended: (a) If ammonium sulfate must be so used, concentrations should never exceed 0.1 per cent and the lines should be flushed immediately afterwards. (b) Ammonium nitrate is relatively safe, but concentrations should not exceed 1 per cent, and the lines should be flushed out immediately afterwards. (c) Anhydrous ammonia, calcium nitrate, sodium nitrate, and ammonium phosphate do not deteriorate concrete. (d) Until more information is gained, such use of soil amendments is not recommended.

These investigations have been largely qualitative because of limited facilities and because of the difficulty of approximating actual field conditions in the laboratory. Nevertheless, it is believed that, if these recommendations are followed, failures of plain concrete irrigation pipe systems should be largely minimized or eliminated.

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Window Insulation

(Continued from page 610)

building to date, however, because of the lack in the past of essential materials, techniques and general information.

For the first time it appears that these handicaps are being overcome. Practical means of entirely insulating buildings including windows are now available and understood. Data are rapidly becoming available on solar radiation rates for many locations. Methods for evaluating these in terms of usable heat are being developed. Large glass areas and ways to shade them have become practical realities. Electrical energy has recently been made available in nearly every home and on practically every farm.

With electricity the means for automatic ventilation have become available. Also, electrical energy provides a practical, convenient and safe form of supplemental heat to hold buildings such as milkhouses, milking rooms, brooder houses and the like at safe minimum temperatures, or to raise their temperatures to the comfort zone when solar energy is not available.

The possibilities of daylight engineering and solar heating open a new frontier in the design of farm buildings. As yet the possibilities for using this natural resource for the benefit of man and animal are undeveloped. It appears that for the first time the tools necessary for its utilization are at our disposal.

Timber Connectors in Farm Structures

By R. H. Gloss

TIMBER connectors may be used to advantage in the remodeling and strengthening of existing farm structures as well as in new construction. In many cases the main structure or shell of an existing building is satisfactory for use if the interior is remodeled to make it more useable. Such remodeling oftentimes involves alteration or removal of interior partitioning which may greatly reduce the strength of the building. Connectors can often be used to strengthen the joints in the main frame to make it satisfactory with the new interior plan.

The repair of existing structures or the frame for heavier loads also frequently favors the use of connectors. Strengthening for heavier loads is particularly necessary in barns where chopped or baled hay is replacing bulk hay storage.

A great deal of progress has been made in the development of typical farm plans which can be easily adapted to specific requirements. Agricultural extension services, specialized plan services, agricultural associations, building material associations and many others have been very active in this work. Many of these plans specify timber connectors, at least at the primary connections, but some need more detail to assure adequate joint strength. Customarily connector joints are detailed as to number and location of connectors and the same detail is needed for nailed or bolted joints if they are to be satisfactory.

There are many firms engaged in the prefabrication of farm structures and without exception engineered principles are followed and timber connectors widely used.

Farm interest in both the typical plans and in prefabricated structures indicates a growing appreciation of the value of engineering for farm structures.

Present-day methods of construction favor timber connectors at many points over bolts and nails. Larger clear floor areas to make buildings more useable with the resultant larger stresses is one decisive feature, but the need for better-built structures, at least in strength at certain critical points, is apparent from a study of storm or snow damage to farm buildings.

Timber connectors simplify joint construction in that one timber connector on the average will equal twenty or more nails or six or more bolts. Although there is some extra effort involved in the installation of timber connectors as compared to bolting or nailing, the finished joint is usually comparable or cheaper in cost than a bolted joint, and much more reliable than a nailed joint which is too dependent upon the quality of workmanship. Connectors may generally be installed in smaller joint areas than either bolts or nails, which means a saving in material since larger members are not required to provide the extra joint area. As an example, a small connector may be installed in the crossing of two 2x4 members, where for equivalent strength it might be necessary to use twelve or more 12-penny nails. It obviously is next to impossible to drive twelve nails in this small area without seriously splitting the members, or to install the equivalent bolts with proper edge distances and spacing.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1949, as a contribution of the Farm Structures Division.

The author: R. H. Gloss, assistant secretary, Timber Engineering Co., Washington, D. C.

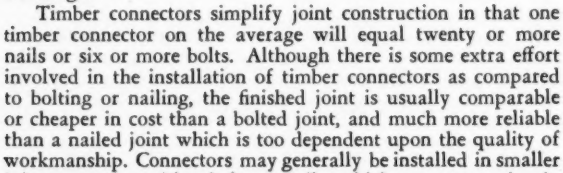

Fig. 1 Three common types of timber connectors: *left,* split ring; *center,* shear plate; *right,* toothed ring

Nails and bolts are perfectly satisfactory for lightly stressed joints or secondary connections but timber connectors are the best solution for major joints.

Joints in which timber connectors may be used are those joints which experience shows have given trouble when framed with ordinary carpentry methods, or joints which analysis shows require a considerable number of nails or bolts. All major joints in truss or clear-span roof construction deserve consideration for connector use. Anchorage of roof system to walls and walls to foundation are other points of importance. Structural bracing members are extremely important from a wind standpoint and should be investigated for connection strength. Joints in grain storage buildings frequently require engineered connections.

Types of Timber Connectors. The most commonly used types of connectors for farm structures are split rings, shear plates, toothed rings and "Trip-L-Grip" framing anchors.

Split-ring connectors are used for wood to wood connections, being installed in precut grooves in the lapping area of two timbers so that half of the connector extends into each member. These are the most efficient of the connectors. They are manufactured in 2½, 4 and 6-in sizes with average load capacities of 2200, 4500, and 7500 lb, respectively.

A power drill is required to operate a grooving tool for the connectors, but this is not a serious drawback considering the fact that experienced contractors who have such equipment do much of the farm construction and many farms have such equipment available.

Shear plate connectors are used primarily for wood to steel connections such as anchorage of a wooden member to a foundation. They are installed in precut grooves cut with a special tool, so that when installed they lie flush with the surface of the wood. They are made in 2⅝ and 4-in diameters and are comparable in strength to similar size split rings.

Toothed ring connectors are made of light-weight corrugated metal with toothed edges and are installed by pressure means to force them into sides of lapped members. Bolt holes are bored first and pressure is usually supplied by means of a high-strength rod, through the bolt hole, which is removed after the joint is pressed together and replaced by an ordinary bolt. They do not require a power tool for installation but the labor cost is usually much higher than for split rings which require power tools. Toothed rings are made in 2, 2⅝, 3⅜ and 4-in diameters. They are recommended for use where power tools are not available or where it is not practical to use power equipment; an example of the latter case is the repair of existing structures where joints are in relatively inaccessible areas or it is too difficult to handle power tools "in the air".

Trip-L-Grip framing anchors are specially shaped steel straps used with nails to provide a stronger and more reliable carpenter joint than can be obtained with conventional nailing. They are manufactured in three styles with a right and left-hand of each, making a total of six types. Nails are provided with the anchors. Typical connections are rafters to plate, studs to plate or sill, framing around openings and joist hangers. *(Continued on page 616)*

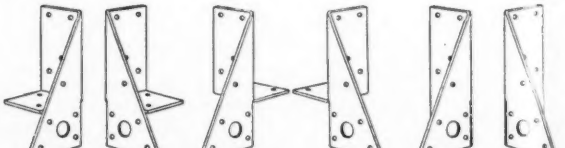

Fig. 2 Trip-L-Grip framing anchors: *left,* type A, *center,* type B, *right,* type C

The Hydraulic Types of Variable-Speed Unit

By Lloyd J. Wolf

THERE are five types of hydraulic drives available which could serve as variable-speed units for the propulsion of combines, as follows:

1 *Thomas Vari-Draulic Drive.* The most widely accepted hydraulic drive to date has been the Thomas vari-draulic drive which consists of an output-shaft-mounted sun gear into which are meshed several planet pinion gears. These pinions are carried by the rotating housing and are free to turn about their axis. Each pinion to sun gear mesh is in effect an oil or air pump. Suitable porting is provided to control the amount of oil or air which is allowed to reach the various gear combinations. Positive remote control of the porting is provided, and output shaft performance is directly proportional to the amount of oil or air which is permitted to reach the gear combinations.

2 *Constant-Displacement Pump and Motor Combination.* This means of providing output-shaft speed variations has been widely accepted in other fields and consists of a suitable pump joined to an oil motor through lines and valves in a manner which will permit a variation in pressure and volume of delivery to the motor. Any variation in volume or pressure is directly reflected in motor output shaft speed and torque. A number of combinations are available—Vickers, Racine Tool, and Berry, to mention a few.

3 *Hydraulic Coupling.* A simple hydraulic coupling exactly like that used in automobiles. A driven member or runner is caused to rotate by an impeller. Air cooling of this unit could be provided by fins on the rotating housing, and for extreme conditions, forced circulation of the fluid through a heat exchanger could be made available.

4 *Hydraulic Coupling Combined with a Full-Torque-Shifting Transmission.* A unit combining the hydraulic coupling with a constant-mesh gearbox would result in the flexibility of the coupling added to the speed changes brought about by the gearbox. A suitable means of clutching the proper gear to provide the desired ratio could be provided for remote control. Probably the most compact unit would be one which employed planetary gears and oil applied clutches or bands similar to the hydra-matic drive.

5 *Variable-Fill Hydraulic Coupling.* This would consist of a coupling provided with a pump and control valve which would permit oil to be pumped to and from the coupling while the coupling is in motion. This combined with an oil sump to carry the oil which was pumped from the coupling and to serve as a source of supply for the coupling would result in a unit which would have variable torque and speed characteristics.

A unit which would suitably fill the requirements of a power source for the propulsion of combines would have to provide the following:

1 Reduction or increase of output-shaft speed to secure decreases or increases in vehicle speed to match crop growth

2 Ability to provide changing torque requirements to meet varying terrain conditions

3 Cutoff clutch

4 Downhill braking ability

5 Control must be positive and rapid

6 Controls should be adaptable to governor control for constant vehicle speed requirements.

Taking the various devices which have been mentioned and applying them to the above requirements would show that the Thomas vari-draulic drive meets all the requirements to a certain extent. It is a compact unit and lends itself well to installation. Continued operation at high-slip speeds would require some external means of cooling and the orifice control may be critical at certain speeds.

A constant displacement pump and motor combination should work out quite nicely. Installation would be no problem and the controls would be simple as well as positive. Speed and torque requirements could easily be met and cooling would present no problem.

With an hydraulic coupling, the first requirement—that of changing vehicle speed to match changing conditions of crop growth—would be lacking. With an unlimited source of power available over that actually required for vehicle propulsion, the coupling could easily match the changing torque requirements of varying terrain conditions. A slight reduction in output shaft speed brought about by an increase in resistance to vehicle propulsion would immediately cause the coupling to absorb and deliver more torque to the output shaft. A 5 per cent pulldown in output-shaft speed could increase delivered torque as much as 100 per cent.

The coupling would provide no cutoff clutch feature. However, its torque delivery at engine idle would be negligible. Downhill braking ability would be equal to the gear train behind the coupling. No controls would be necessary.

In an hydraulic coupling combined with a full-torque-shifting transmission a step-change gearbox with small enough ratio changes would very nearly meet all of the requirements. The flexibility of the coupling would greatly add to its ability to meet changing torque requirements.

The cut-off clutch would be a part of the transmission and downhill braking ability would be good. The control system would be simple and would lend itself to governor control.

A variable-fill hydraulic coupling would meet all of the requirements. Reductions and increases of output-shaft speed and torque would simply involve valving enough oil in or out of the coupling to match the condition. A full cutoff clutch is provided by pumping all of the oil out of the coupling. The time required would be a matter of perhaps one second. Downhill braking would be identical to that of a simple coupling. Control would be positive and rapid, and governor control could be easily accomplished. The installation of a package of this kind would provide no particular problem.

In summarizing the various types of hydraulic variable-speed devices which are available, it would appear that each has enough merit to justify its use. The determination of which is to be used must be decided on the basis of cost in dollars, space, and overall efficiency.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1949, as a contribution to the Power and Machinery Division.

The author: LLOYD J. WOLF, chief engineer, Twin Disc Clutch Co., Racine, Wis.

Discussion by Martin Ronning*

MEMBER A.S.A.E.

THE Thomas vari-draulic unit consists of a planetary-gear pump using three planetary gears and one sun gear to form the pump unit. The rotating housing and the planetary gears are the driven unit which rotates about the sun gear that is keyed to the output shaft. Also incorporated in the sealed unit is an intake valve which, with its axial movement, can feed all air or a controlled variable mixture of air and oil, ranging from all air to all oil, through the pump.

To obtain neutral, the intake valve is moved axially to allow all air to be the circulated medium, thus allowing the planetary gears to coast around the sun gear which is the stationary member in neutral.

Movement of the intake valve towards the full engagement position allows the oil-air mixture to be the fluid drawn through the rotating pump. This air-oil mixture creates a drag on the three planetary gears which are, in turn, imposed on the sun gear thus producing the lower speed torque range.

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Upon reaching the all-oil range of valve travel, a discharge valve then begins to restrict the discharge flow of oil thus producing the higher speed torque range. At full engagement position, the discharge valve has completely arrested the fluid flow, thus creating a substantially positive direct drive. At this adjustment, the unit falls into the hydrostatic class of couplings as there is practically no fluid flow or gear rotation at the full engagement position.

The unit is also provided with relief valves set to allow slippage at a torque load of approximately 35 hp. This prevents overstressing the transmission belts and mechanism if an attempt is made to pull out of a hole or go up a steep hill in a higher gear than should be used.

This drive has been incorporated in the Minneapolis-Moline Model S harvester, which normally has a 14-ft width of cut, but has a 13-ft cut on rice machines and a 12-ft cut for specially heavy crop conditions.

Three forward field speeds and a road speed are provided in the transmission. In field operation, a gear speed is selected which will give the maximum speed practical at any area of the field. The operator can then quickly and easily control the forward speed of the harvester at any desired speed from zero to the full speed of the particular gear which may be engaged.

VARIABLE SPEED ADVANTAGE OF VARI-DRAULIC DRIVE

The ease with which the vari-draulic drive can be regulated to vary the forward speed of the harvester is a great advantage in that the speed can be instantly changed to suit the condition of the crop and the terrain immediately ahead of the cutting mechanism.

The machine can be kept working substantially up to capacity even though the crop may vary from light to heavy throughout the field. Also, when eroded areas and gullies are crossed, minimum time is lost in slowing down and again bringing the machine back into the desired forward motion.

Perhaps the most ideal power arrangement on a combine harvester would be one making use of two power plants, one to operate the threshing mechanism and the other to propel the machine. This, however, is not considered practical from either the initial cost or the operating economy standpoint.

The operating characteristic of the vari-draulic drive closely approximates that of the two-power-plant machines. However, it is obvious that when difficult ground conditions are encountered an unusual amount of the power is absorbed in propelling the machine, causing a drop in speed of the engine which results in slowing down the combine threshing mechanism. Under practical conditions, however, we find this is not serious as a sufficiently large engine is used to carry the load without too much pulldown except under extreme conditions.

We feel that the use of this drive on our harvester eases the strain on the machine to a considerable extent, due to the drive having a certain amount of cushion effect. For instance, on a rice harvester which has to continually cross irrigating borders, we find that when the drivewheels hit the borders, the additional load imposed in lifting the machine over the border has the effect of slowing the forward speed to a considerable extent. In this connection, it might be mentioned that the machine would increase its forward motion in going downhill. This, of course, is true, but since the controls are in a convenient position and easily operated, the adjustment can be quickly made to reduce the forward speed as desired.

We understand that a design is now being worked out by engineers of the Thomas Hydraulic Co. which will, to a considerable extent, reduce the tendency of the machine to increase the forward motion on a downhill slope.

It has been our experience that, in order to achieve the proper efficiency with the vari-draulic drive, a well-designed control system is required as the axial movement of the valve in the unit is approximately ½ in so that it is necessary that there be no looseness anywhere in the linkage of the controls. We did not give enough attention to this detail when we first adopted this unit for the Model S harvester, but this has since been improved with the result that forward speeds can be controlled more accurately.

Timber Connectors in Farm Structures

(Continued from page 614)

While they are more expensive than conventional nailing, the added cost on an average-size structure is negligible compared to the improved strength and added insurance against structural troubles. They may be used to advantage in the repair and strengthening of existing structures as well as new work.

Through a continuing program of research and product development, the Timber Engineering Company endeavors to provide the most efficient means for timber connections. The company maintains its own testing laboratory in Washington, D. C., carries on cooperative test work with the USDA Forest Products Laboratory and works with other research organizations, including colleges and universities, on problems relating to timber and its connections.

Each year at least several new types of connections are investigated, comparing them to existing types in hopes that new or better connectors may be developed. Present-day split-ring connectors are a result of product development. The present style is the third used, each new style being superior in some manner to older styles.

In addition to research on connectors themselves, there is always the problem of developing better systems of framing. Considerable progress in knowledge of connectors and in design procedures have been made. Many of these have been proven through research projects. There are presently several long-duration load tests investigating the performance of full-scale trusses and individual joints where design load is applied over a long period of time in place of a short-duration load in a testing machine. Present tests of this sort involve a 50-ft span-pitched truss which has been under load for 3 yr and an individual split-ring joint under load for 3½ yr.

As the problems arise, research projects are developed to attempt to provide the answers, and in this way farm and other industry are assured of the best possible information on timber design.

UNIFORM FARM BUILDING STANDARDS ARE NEEDED

Engineering procedure and design standards are well developed for use in urban areas. Local building codes set the standards with respect to design loads and working stresses. Such is not true of farm construction and engineered construction is handicapped in the farm field by lack of uniform building standards. If the urban standards are applied to farm structures, the resulting design is much too expensive in comparison with existing structures which the owners or prospective builders regard as satisfactory. The answer of course is that many existing structures are not at all adequate, based on customary engineering principles.

To increase the use of engineered farm structures, it is necessary to do one of two things, either to develop farm design standards on the basis of lighter built existing structures or to convince the farm builders that the existing lighter structures are too light and consequently a bad risk. Since the personal risk involved in a farm structure is not as great as in other types of construction, the probable answer to the question lies somewhere between the light carpenter-built structures and the heavier urban standards. Too often the builder does not like the looks of an engineered structure and goes ahead without any engineering advice, to build in his own manner, the result being that the structure may be very poorly balanced in that it is overstrong at some points and critically weak at others.

An engineered structure is never too expensive. The responsibility of the engineer is to follow design recommendations and to do the best job possible with the material available. When design recommendations for farm structures are developed and accepted to the extent of building codes, the engineered structure will receive its proper recognition in the farm field. Most engineers specify timber connectors so the use of timber connectors in farm structures will naturally increase as engineering is applied to farm buildings.

Chemicals for Drainage Ditch Maintenance

By L. S. Evans

CHEMICAL measures are often used to supplement mechanical operations needed to rid drainage ditches of undesired vegetation. Ditchbank weeds (land weeds) aggravate the maintenance problem. They hinder the flow of water, sometimes to the extent that water flow is stopped and overflows result. Weeds and other plant debris may clog control structures, pumps and screens, requiring hand removal. In addition, they serve as a source of potential weed infestation to cropland and may harbor insects and diseases attacking agricultural crops.

Channel weeds (water weeds), because of their desilting action, build up silt bars that restrict water flow and may necessitate costly cleaning and dredging. The problem of controlling channel weeds has been extensively studied in irrigated regions, but some of the general principles may be equally applicable in drainage ditches of the humid areas. Unless the conditions that favored the encroachment of water weeds are substantially changed, reinfestation will soon occur. Careful planning in the initial construction of ditches can often simplify subsequent maintenance requirements. Channel weeds are apt to be troublesome in low-gradient ditches carrying relatively clear water.

A general understanding of the types of waterweeds involved is a prerequisite to a successful chemical control program. Waterweeds can be grouped in three categories (a) floating plants, (b) emergent plants, and (c) submerged plants. The floating plants like water hyacinths are normally not anchored in the soil. The emergent plants are found mostly in drains and shallow water of low velocity where they are rooted in the silt along the sides and bottom of the ditch. Tules, cattails, and water cress are examples of this group. The submerged plants may blossom above the water or have some floating leaves but actually grow beneath the water surface. This latter group may be rooted in the bottom like pondweed or as in the case of coontail, which does not produce roots, is free to float beneath the water surface.

There are many forms of pondweeds with widely varying anatomical characteristics that make positive identification difficult—a job for a skilled taxonomist. Research on chemical control of waterweeds has so far been confined to a relatively small number of troublesome species. Enough work has been done to show that species vary widely in their ability to withstand exposure to chemicals. Time of exposure and concentration factors have been determined under limited environmental conditions and show that water temperature is an important factor governing the response of plants to chemical treatments. The dosage problem is further complicated by several different species or genera growing in close association. The effect of factors like pH of the water, soluble salt content and other conditioning factors are not clearly understood. Until more data are available, local trials on a small scale will be advisable in order to modify the basic treatment for maximum effectiveness.

A good example of the successful use of chemicals for aquatic plants in drainage ditches has been the water hyacinth control program of the Everglades Drainage District of West Palm Beach, Florida. The initial work was started in 1946 using airplanes to apply the butyl ester of 2,4-D in diesel oil. In 1949 the control program had advanced to the stage in the arterial canals that operations had been reduced to a patrol basis, using boat-mounted sprayers to destroy scattered plants that move into the canals from Lake Okeechobee. Benefits from the standpoint of improved drainage are hard to evaluate but are considered substantial. From observations in this area, it is apparent that a control program must be undertaken with a view to carrying it through the mop-up stage; otherwise the venture is a complete waste of time and money. The sources of infestation must be attacked, in the ofttimes inaccessible areas; otherwise they will reinfest the cleared canals. Searching out and destroying the last hyacinth plant in a canal may be a futile operation, but some degree of maintenance is required to deal with the seedlings that may arise along the canal banks and with migratory plants.

Copper sulfate is often used for algae control, but the amount of chemical needed for controlling higher plants may be prohibitive in cost. Benoclor, a chlorinated benzene preparation, plus emulsifying agents, is effective against a wider range of submerged plants in both flowing and still water. It is often used for aquatic weeds in lakes and ponds to facilitate boating, fishing and swimming. This compound also kills fish, crayfish and mosquito larvae. In flowing water, the liquid is forced into the water under pressure and the emulsion kills or injures the exposed plants as it is carried downstream. The action of the chemical is rapid and the weed growth deteriorates quickly. An exposure time of one hour to concentrations of 300 ppm is a typical treatment for flowing water. This method is costly, but there is little danger to growing crops if the treated water is later used for irrigation. For static water bodies a less miscible form of Benoclor is used that settles to the bottom when the emulsion breaks.

A more recent development in hydrocarbon weed killers is the use of aromatic solvents (solvent naphtha) of petroleum or coal tar derivation. These compounds are used commercially as paint thinners. Chemists and physiologists of the Bureau

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Washington, D. C., June 1950, as a contribution of the Soil and Water Division.

The author: L. S. EVANS, formerly agronomist, Weed Investigations (BPISAE), U. S. Department of Agriculture.

(*Left*) Uncontrolled Johnson grass clogs water-delivery canal in Arizona • (*Right*) Johnson grass destroyed on canal bank in Arizona by four applications of an aromatic petroleum oil. (Photographs by Harry W. Myers)

TABLE 1. GUIDE FOR USE OF CHEMICALS IN AQUATIC WEED CONTROL

Chemicals	Type of Treatment or situation	Rate of application*	Principal weed species affected	Effect on aquatic animal life	Other side effects or precautions in use
			Submerged Aquatics		
Aromatic solvents (See text for specifications)	Underwater spraying in flowing water. Treat before plants impede flow of water. Not suitable for static water	300 ppm for 30 min at initial station (4 gal per cfs.) Booster shots at ½-mile intervals. Required dosage depends on species of weeds	Pondweeds (*Potamogeton* spp.) Horned pondweed (*Zannichellia palustris*) Waterweed (*Anacharis* spp.) Various algae incl. *Chara* spp Coontail (*Ceratophyllum demersum*)	Highly toxic to all forms	Aromatic solvents are inflammable. Low toxicity to crop plants. Water temperature affects efficiency of emulsifiers. Loss of chemical due to absorption by plants and silt particles and evaporation when emulsion breaks
Benoclor 3C	Underwater spraying in flowing water For static water — use less miscible Benoclor.	300 ppm for 60 min. Booster shots at ½-mi intervals.	Horned pondweed (*Z. palustris*) *Chara* *Anacharis*	Highly toxic to all forms	Kills vegetation rapidly. Emergent species must be cut below water line. Imparts unpleasant taste to water but low toxicity to crop plants
Copper sulfate	Water-surface spray for small ponds	2 ppm	*Chara* Algal scum (*Cladophora spp*)	None at concentration prescribed	Favors production of toxic "water bloom." Keep livestock away from points of application
Sodium arsenite	Water-surface spray for small ponds	1 - 2 ppm	Pond scum algae *Anacharis*	None at concentration prescribed	Stock poisoning hazard. Maximum tolerance in drinking water is 0.05 ppm
Inorganic fertilizer 10-5-5	Most economical for large ponds and lakes	1 ppm (approx) 100 lb per acre	Produces algal bloom of filamentous algae that shades out submerged plants	See next column	Excessive fertilization (10 ppm) favors pond scum algae causing oxygen depletion and poor fishing
Nigrosine (black analine dye)	Large shallow lakes Dye dumped in at several points	10 lb per acre (ppm not determined)	*Myriophyllum* spp	No serious effects noted	Slow acting — maximum effect in second season. Temporary increase in plankton. Lowers water temperature
			Floating and emergent aquatics		
2,4-D	Boat-mounted sprayers or airplane application of concentrated sprays for large water bodies	0.1 to 0.2 per cent foliage spray (2-4 lb act. ingred per acre)	Water hyacinths (*Eichhornia crassipes*) Pennywort (*Hydrocotyle spp*) Water primrose (*Jussiaea californica*)	No direct effect or concentration prescribed. See next column for indirect effects	Decaying vegetation causes temporary oxygen depletion in underlying water. Drift of spray or volatile fumes will damage nearby sensitive crops
General contact sprays Oils Fortified oil emulsion Dinitro compounds Ammonium sulfamate	Contact sprays must cover and wet the foliage. Wetting agents aid in getting complete coverage	Dosage will depend on material and species involved, usually100-150 gal per acre	Top growth of most species destroyed. Perennials will require several treatments, e.g. cattails (*Typha* spp.) tule (*Scirpus spp*)	None at usual weed killing dosages	For use against species resistant to 2,4-D or where 2,4-D drift endangers adjacent field crops

(See also Table 2 for ditch bank weeds)

* These rates are guides only and should be adjusted to meet local conditions and experience.

of Reclamation (USDI) and Bureau of Plant Industry, Soils and Agricultural Engineering (USDA) discovered the potency of this group of compounds on aquatic plants. Other hydrocarbons are also effective but so far none have been tested that compete with aromatic solvents in availability, efficiency, and cost. Materials with the following specifications are recommended:

Flash point, not less than	80F
ASTM D-86 distillation—	
Starting point	278F
Not more than 10 per cent	286F
Not less than 90 per cent	395F
End point, not higher than	420F
ASTM D-875, aromatics per cent, not less than	85F

The aromatic solvent mixed with emulsifying agents (5 per cent by volume) of the oil-soluble petroleum sulfonates type forms a milky emulsion when sprayed under water. Water temperatures affect the efficiency of the emulsifiers. If the water temperature is 60F, 10 per cent emulsifier is needed while at 70F, 5 per cent is satisfactory.

Small power spray equipment to provide a steady flow of chemical to the nozzles can be used for the application. Special silicone greases have a low solubility in the aromatic solvent and should be used for lubricating the pump. Neoprene or similar synthetic rubber hose used for the delivery line resists deterioration better than natural rubber. Cone-shaped or fan-shaped spray nozzles that deliver accurately are kept submerged during application. If nozzles are located so as to discharge upstream against the current more effective dispersion of the chemical is obtained. Thorough mixing in the water is essential for uniform effectiveness. Silt particles absorb the solvents and in turbid water the concentration of chemical may be increased to compensate for this loss.

A minimum concentration of 370 to 444 ppm maintained for a period of 30 min is suggested as the basic treatment at the first station. (Five to 6 gal of solvent per cubic foot of water per second applied in a 30-min period is equivalent to 296 ppm.) Reinforcing injections are needed at intermediate downstream points to maintain the concentration-contact time ratio. These booster shots are made at one-half mile intervals at about one-half the rate of application used at the initial point.

The number of treatments needed for effective control during the season will vary from one to four, depending on the length of the growing season and the rate of recovery. The roots of the submerged plants are not affected by the chemical and recovery may be rapid in warm weather.

At the concentrations used for aquatic weed control the contaminated water does not harm cultivated crops when used for irrigation. Much of the solvent is dissipated by evaporation as soon as the emulsion breaks. Like Benoclor, the aromatic solvents are toxic to animal life in the water.

Field experience with the aromatic solvents has been too limited to allow broad generalizations in cost comparison between chemical and mechanical control methods. Some irrigation specialists believe that the chemical method can be used more economically on small ditches and drains. For the larger capacity water channels the amount of chemical required to build up a lethal concentration may run the cost higher than chaining or other mechanical methods. In any case, the labor requirement for the chemical method is a minor item. The chemicals do not have a residual effect, but their repeated use will gradually diminish the infestation whereas mechanical methods definitely spread the infestation. Probably one of the most significant advantages of the chemical method for drainage ditches is the fact that access to the ditch is only required at the initial injection point and at approximately one-half-mile intervals downstream. On the other hand, mechanical methods require continuous access roads on one or both sides of the channel.

The use of the aromatic solvents for waterweed control has grown rapidly in the western states since the first field trials in 1948. Petroleum refineries, especially in California, are the chief suppliers, the price range being from 20 to 40c per gal. Some producers have ready-for-use mixtures containing the solvent and emulsifying agent at somewhat higher prices.

Field and laboratory research is continuing in an effort to refine the technique and determine more accurately the exposure time-concentration ratio best suited for a variety of operating conditions.

The materials and methods used for chemical control of ditchbank vegetation are similar in most respects to those used for many land weeds. Chemical control of land weeds has been extensively studied and reported in detail in many publications. No attempt is made to review this information in detail but rather to condense the information in tabular form for use as a guide to ditchbank weed control with chemicals, pointing out whenever necessary, modifications that are needed to fit the special requirements of the situation.

Some plants cannot be classified exclusively as either land or water weeds because of their ability to adapt themselves to fit their environment. Some plants can tolerate a wide range of moisture conditions and can exist, temporarily at least, in drier or wetter habitats than their normal requirements. These borderline cases are included in the group of plants they most nearly resemble. A few truly amphibious plants like alligator weed present special control problems depending on whether they are found in the terrestrial or aquatic phase. Besides the water requirement, other factors such as seasonal temperature will affect the distribution and adaptation of species.

The same precautions with respect to the safe use of herbicides apply to ditchbank spraying as to any other weed-spraying job. Special attention should be given to steps that will confine the chemical to the objectionable vegetation. Spray nozzles should not be elevated above the point needed to secure adequate coverage. High pressures cause a finer breakup of droplets than low pressures and a consequent increase in drifting of spray particles by air currents. This factor is especially important in using 2,4-D compounds near sensitive crops. Spraying operations should be shut down during windy weather. An effective way to avoid crop injury is to spray the weeds during the off season. Successful use has been made of basal sprays to intact trunks or cut surfaces of woody plants during the dormant season. This adds versatility to the treatment by prolonging the period during which weed control operations are effective and utilizes labor during the slack season. Concentrated solutions of 2,4-D or 2,4,5-T esters in an oil base carried in knapsack sprayers are recommended for this purpose making it possible to reach places inaccessible to large power-spraying equipment.

Several of the recently discovered herbicides may have potential use for ditchbank maintenance. Their probable use is still in the speculative stage. More and more weed research is directed toward finding chemicals suited for specific weed-killing jobs recognizing that no one chemical method is the best for all or even a majority of the situations encountered.

If an estimate of the situation shows that chemical methods can be effectively used, a decision as to which chemical method should be used must take into account materials, methods, cost, convenience, available equipment, and labor as well as any adverse effects that may result from chemicals. Unskilled labor requires close supervision when dealing with herbicides if satisfactory results are to be obtained. The popularity among farmers and widespread use of 2,4-D for selective weeding of agricultural crops and the growing public awareness of other new and potent agricultural pesticides should not lead one to the false belief that chemicals are the simple and easy solution to all of our weed problems. Other time-tested methods are often more reliable and less expensive.

Tables 1 and 2 have been prepared as a guide to those contemplating chemical weed control. The information is taken from various sources and represents basic treatments that are subject to modifications based on local trials and additional research work.

TABLE 2. GUIDE FOR USE OF CHEMICALS ON COMMON DITCHBANK WEEDS

Type of action*	Chemical compound or derivative	Type of treatment	Normal dosage (Per acre basis)	Remarks	Effect of chemical on representative species‡	
					Can control	Does not affect
Selective herbicides	2,4-D	FS†	1 - 4 lb per acre in 200 gal water	Ester formulations (in oil) more effective on "hard to kill" species	Cattail, elderberry, morning glory, poison ivy, willows, sumac, honeysuckle	Evergreens, ground cherry, ash, hickory, maple, oak, raspberries, most grasses
	2,4,5-T	FS	2 - 4 lb per acre in 200 gal water	Ester formulations (in oil) often preferred for woody plants	Sweet gum, osage orange, some oaks, elm, maple, blackberry, hickory, ash	Selectivity on most species not yet established
	Mixtures of 2,4-D 2,4,5-T	FS	2 - 4 lb per acre in 200 gal water	Combinations are more effective against mixed stands of woody perennials	A majority of woody and herbaceous perennials	Most grasses
Non-selective herbicides (contact)	Oils (diesel)	FS	150 gal per acre	Special weed-killing aromatic oils are more toxic than diesel (see fortifying agents below)	Kills top growth of most weeds. See next column for oil-tolerant spp.	Sweet fennel yellow star thistle, may weed
	Penta-chloro-phenol	FS	4 lb per 100 gal of oil. Spray to run off	Oil soluble form used to fortify oils or oil emulsions. Salt derivatives used in water or oil emulsion	Kills top growth of most weeds and grasses	Most perennials require several applications
	Dinitro phenol	FS	1⅓ lb per 100 gal of oil. Spray to run off	(See above)	(See above)	(See above)
	Ammonium sulfamate	FS	¾ - 1 lb per gal water. Wet foliage to run off		Poison ivy and other shrubs	Transient effect on perennial grasses
Temporary soil sterilants	Sodium chlorate	SA	600 lb per acre (Dry or spray applic.)	Fire hazard is less if applied in dry form	Kills most weeds and grasses	White top, camel thorn
	Borax	SA	1800 lb per acre (apply dry)	Prolonged soil sterilization but slow initial kill because of low solubility. No fire hazard	Kills most weeds	Many grasses are resistant. Mixture of 6 parts Borax, 2 parts chlorate gets all species
	Sodium trichloro-acetates	SA/FS	100 - 200 lb per acre dissolved in 200 gal of water	1 - 3 months soil sterility. Can be used as contact killer	Johnson grass, Bermuda grass, quack grass para grass, and most annual grasses	Further trials needed to establish tolerant species

* This classification is only approximate because certain chemicals can be used in more than one category by adjusting dosages.

† FS indicates foliage sprays applied to succulent young growth; SA indicates soil applications irrespective of stage of growth.

‡ Weeds listed in column "Can Control" may require repeated applications; those listed in column "Does Not Affect" cannot be economically controlled. See USDA Farmer's Bulletin 2005 for more detailed list of species reaction.

Calibration of Splash Cup for Soil Erosion Studies

By Frederick Bisal
ASSOCIATE A.S.A.E.

DETACHABILITY tests on soils using a soil splash cup (3½-in diameter by 2 in deep) have been described by a number of workers (1, 2)*, but in these tests the effect upon the splash of the progressive lowering of the soil in the cup was not determined. It is the purpose of this paper to outline the method by which a formula was derived to give the amount of standard sand that would splash from a cup kept level full by the depth of sand splashed from a standard cup.

The determined value of the amount of sand splashed from a level-full splash cup was obtained by means of a specially constructed apparatus to hold the sand at a constant level. This consisted of a splash cup with a movable false bottom†, which was operated manually during the application of a simulated rainfall. A rainfall simulator and a rotating table, as described in water erosion papers(1), was built and modified to meet the particular need.

The apparatus was set up with two cups having movable false bottoms and two of the conventional-type splash cups on the rotating table. A piece of oilcloth was used to cover the cups and removed when the application of rain on the sand was desired. The rainfall simulator screen was placed at an elevation of 20 ft above the tops of the cups on the rotating table and was fitted with wool thread from which a 4.88 mm drop fell. The nozzle delivered a mist spray which was evenly distributed over the screen. For the experiment, the drop size, velocity and intensity were constant and the time of rainfall application was varied. The rainfall was applied for periods ranging from 10 min to 1½ hr.

A standard graded sand was used, which had been washed free from foreign matter. The splash cup filled level full with ovendry sand held 480 g. This gave a value of 9.45 g per mm depth of the cup. The constant levelling cup with the movable false bottom, on which a cloth soaked in a wetting agent had been placed, held approximately 400 g of sand. The conventional cup held approximately 475 g when the bottom of it was covered with a cloth soaked in a wetting agent. It was necessary to have the conventional cup level full at the beginning of each test but not so with the constant levelling cup as the adjustment was made by means of the false bottom.

The cups, after being filled with sand, were placed in a pan which contained enough water to moisten the sand to its water-holding capacity. The cups were then placed on the rotating table and covered with the oilcloth. The rainfall simulator was started and when the intensity was constant, the oilcloth was removed. The cups with the false bottoms were watched closely and adjusted during the time of the test to keep the sand surface level with the rim of the cup. The first interval of time was approximately 10 min after which the cups and the two rain gages were covered with the oilcloth. The rainfall simulator was stopped and the cups and rain gages removed. The amount of rainfall was carefully checked, the cups were set in a drying oven and after the sand was dried, it was carefully weighed. This procedure was repeated with the time increased by approximately 15 min for each test up to the last one, which was of approximately 1½ hr duration.

The difference in the ovendry weight of the sand at the beginning and end of a test run gave the amount of sand which splashed from the conventional cups and from the level-full cups. The amount which had splashed was converted to millimeters of depth of sand by the factor 9.45 g per mm of depth.

Fig. 1 shows the experimental data obtained. Curve A has as ordinate the splash from a constant level full cup (converted to millimeter depth of sand) and as abscissa the rainfall in centimeter of depth. The relationship is linear and may be expressed by the equation

$$S_1 = 2.057\ R + 0.772 \quad \text{.....[1]}$$

where S_1 is the splash in millimeter depth of sand and R is the rainfall in centimeters. For values of R approaching zero, the graph cannot be linear but must pass through $S_1 = 0$.

Presumably, at the start of the experiment, some condition such as the initial smoothness or dryness of the sand permits a greater than average rate of splash.

Curve B has as ordinate the depth of sand splashed out of the conventional cup and as abscissa the rainfall in centimeters. The experimental values may be represented by the equation

$$D = 2.615\ R^{0.675} \quad \text{.....[2]}$$

where D is the depth from cup rim to the sand level in millimeters. The change of depth with rainfall is not constant but decreases as the sand is lowered in the cup. This is expressed by the relation $dD/dR = 1.765\ R^{-0.325}$.

Eliminating R from equations [1] and [2] the equivalent splash from a full cup may be found from the depth of sand splashed from the conventional cup, viz:

$$S_1 = 2.057 \left(\frac{D}{2.615}\right)^{1.481} + 0.772 \quad \text{.....[3]}$$

(Continued on page 622)

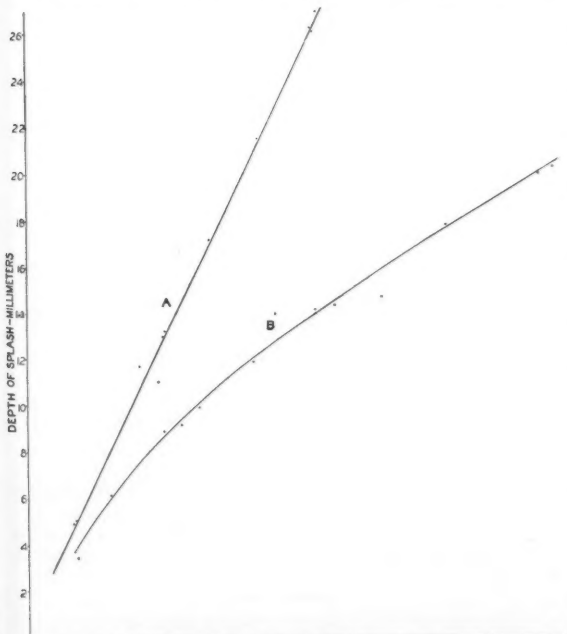

Fig. 1. Curve A, standard sand splash curve made with constant levelling cup. Curve B, standard sand splash curve made with conventional cup

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

The author: FREDERICK BISAL, agricultural research officer, soil research laboratory, Department of Agriculture, Swift Current, Sask.

AUTHOR'S NOTE: The author extends thanks to Dr. J. L. Doughty, officer-in-charge, and to W. J. Staple for suggestions in the preparation of the paper; E. A. Christiansen, for technical help; and G. N. Denike, superintendent, Dominion Experimental Station, for making available the facilities of the station drafting laboratory, Swift Current, Sask.

* Numbers in parentheses refer to the appended references.

† Full-scale blue prints of the splash cup with moveable false bottom can be obtained from the Dominion Experimental Station, Swift Current

Stall Equipment for Experimental Steer Feeding

By T. B. Keith, R. F. Johnson and W. R. Friberg
ASSOCIATE A.S.A.E.

ACCURATE measurement of the exact quantity of feed consumed by individual experimental subjects is a difficult problem for livestock investigators. If the equipment used interferes with the normal physiological functions of the experimental animal, the data obtained may not be adapted to the feeding of livestock under natural conditions. Therefore, equipment has been designed to enable investigators to obtain accurate data from experimental steers fed in an environment common to that in which livestock is produced.

The unit shown in Fig. 1 is a three-stall structure. It may be built for any number of animals. If it is planned to move the equipment frequently, a three-stall unit structure is the most desirable. If the equipment is to be permanent, a ten-stall unit or larger structure may be built.

These stalls are designed to be used where an exercise lot is available. The animals are to remain in the stall only during the time required to eat the allotted feed. The experimental animals may be fed twice or three times daily.

Details of Structure. The individual stall plus manger is 12½ ft long and 3½ ft wide. The manger space for each animal is 3½ by 3 ft, outside measurements. The stall minus the manger is 8 ft long and 3½ ft wide. These dimensions are large enough to hold a mature beef animal.

The manger floor is one foot from the concrete floor. The height of the rear side of the manger where the animal receives feed is one foot from the manger floor. The top of the front side of the manger is 2 ft from the manger floor with the lower portion sloping toward the animal. A 2 x 6 (lower K) is placed above the animal's neck to prevent him from climbing into the manger. This piece may be lowered or raised depending upon the size of animal being fed.

The entrance panel shown in Fig. 1, is designed to be constructed with 1 x 4-in material. The light material used makes it possible for the person feeding and handling the animals to lift the panel without extra effort and reduces the chance for injury of the experimental animals.

The equipment may be dismantled without destruction. The manger is a separate unit of the structure. The partitions and rear panels are separate units. The partitions are bolted to piece J of the manger and are held in position with piece Q and the dowel pin attached to piece P and embedded in concrete as illustrated in Fig. 1. The manger posts H may be attached to the concrete with dowel pins or with angle iron as shown in Fig. 1.

If it is desired to move the equipment for storage or other purposes, the three-unit stall may be constructed. When it becomes necessary to move the equipment, the bolts that fasten pieces Q and P and L and J are removed. The partitions and panels are disassembled and the dowels embedded in the concrete are removed. A ten-unit stall may be constructed and when it becomes necessary to change from a project on studying individuals to that of studying rations fed to groups, the partitions and panels may be removed, leaving the manger in its original position.

This paper was prepared expressly for AGRICULTURAL ENGINEERING and is published with the approval of the Director of the Idaho Agricultural Experiment Station as Research Paper 315.

The authors: T. B. KEITH, R. F. JOHNSON, and W. R. FRIBERG are, respectively, professor of animal husbandry, superintendent of Caldwell Branch Station, and associate professor of agricultural engineering, University of Idaho, Moscow.

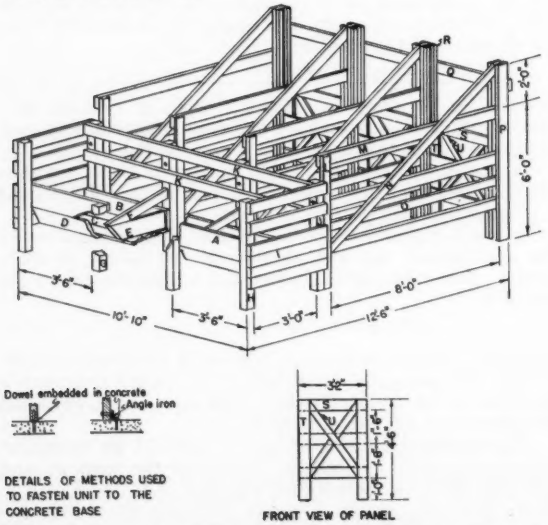

Fig. 1 Structure and dimensions of the three-stall unit for the feeding of steers on experimental rations

Materials and Dimensions

Feeder	Number of pieces	Size in	in	ft	in
Front, A	1	2	12	10	10
Back, B	1	2	12	10	10
Floor, C	4	2	8	10	10
False back, D	1	2	12	10	10
Partition, E	2	1	12	2	8
Brace, F	2	2	6	3	9
Studding, G	2	4	4	3	0
H	2	4	4	5	0
Side, I	12	2	6	3	8
Studding, J	4	4	4	5	0
Rails, K	2	2	6	10	10
Four partitions					
L	4	2	4	6	0
M	12	2	6	8	8
N	4	2	6	11	0
O	4	2	4	8	8
P	4	2	6	8	0
Q	1	2	6	10	10
R	12	2	2	8	0
Panels					
S	9	1	6	3	2
T	6	1	6	4	5
U	6	1	4	4	9

Splash Cup for Erosion Studies

(Continued from page 621)

S_1 must be multiplied by 9.45 to give the amount of splash in grams.

SUMMARY

Standard sand (60-70 mesh sieve) did not pack when exposed to simulated rainfall but splashed at a constant rate. The equation [3], which was derived, is essential to determine the detaching capacity of a given rainfall when splash cups are used.

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1 ELLISON, W. D.: Soil Erosion Studies — Part II. AGRICULTURAL ENGINEERING, 28: 197-201 (May, 1947).

2 WOODBURN, RUSSELL A.: The Effect of Structural Condition on Soil Detachment by Raindrop Action. AGRICULTURAL ENGINEERING, 29: 154-156 (April, 1948).

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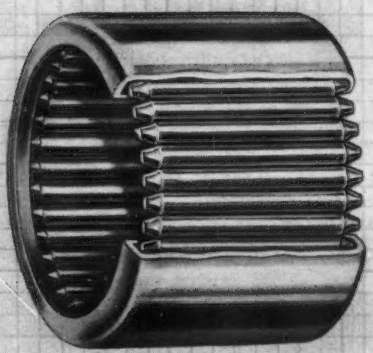

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NEWS SECTION

Hurd New Chairman of Pacific Northwest Section

CLARENCE J. HURD, owner, Hurd Farm Electric Supply at Spokane, was elected the new chairman of the Pacific Northwest Section of the American Society of Agricultural Engineers at its meeting at Yakima, Washington, October 19 and 20. Four new vice-chairmen of the Section also took office at this meeting. The first vice-chairman is F. N. Johnson, manager, irrigation department, Armco Drainage and Metal Products, Inc., Portland. The second vice-chairman is Paul K. Fanning, extension agricultural engineer, State College of Washington. The third vice-chairman is Ralph H. Gram, supervisor of agricultural services, British Columbia Electric Railway Co. The fourth vice-chairman, and representative of the ASAE Student Branches in the area, is Andrew Linn.

The new secretary-treasurer of the Section is Robert M. Morgan, manager, irrigation division, R. M. Wade & Co., Portland.

A total attendance of 127 were registered at the meeting, and a very interesting program was presented. During the business session of the meeting it was voted to hold the 1951 meeting of the Section in the Pullman-Moscow area.

Earl Anderson Heads Chicago Section

EARL D. ANDERSON, secretary, National Sprayer and Duster Assn., was elected chairman of the Chicago Section of the American Society of Agricultural Engineers at the Section meeting on October 16. He succeeds Henry F. Carroll, manager, farm equipment div., Montgomery Ward & Co. Other officers elected include two vice-chairmen, C. L. Hamilton, agricultural engineer and assistant director, farm division, National Safety Council, and J. P. Bonfield, U.S. Gypsum Co. Morris L. Burgener, agricultural engineer, Portland Cement Assn., was elected the new secretary-treasurer of the Section.

The Section meeting was held at the research laboratory of the Standard Oil Co. (Ind.) at Whiting, Ind. The program included motion pictures showing the process of refining petroleum into its various products, which was followed by a visit through the laboratory with particular attention given to various phases of the refining process, including grease processing, insect breeding and insecticide testing, demonstration of analytical instruments, testing procedures for lubricating oils, and pilot plant operations. A complimentary luncheon was served to ASAE members and their guests.

Alabama Section Fall Meeting

THE Alabama Section of the American Society of Agricultural Engineers held its fall meeting at Auburn on October 27 and 28, with an attendance of 81 ASAE members and guests, including a generous sprinkling of members of the local ASAE Student Branch.

The theme of the program was agricultural engineering teaching, with the opening talk by Dr. E. G. McKibben, principal agricultural engineer, U.S. Tillage Machinery Laboratory, discussing agricultural engineering as a general education. This was followed by two Alabama extension service specialists, W. H. Gregory, Jr., and G. B. Phillips, who discussed the relation of agricultural engineering to beef cattle and machinery and swine production and housing. The forenoon program was concluded with a panel discussion on the relation of electric power to agricultural engineering. The panel members included J. T. Gaillard, agricultural engineer of the Alabama Extension Service as leader, and M. V. Stephens, instructor in rural electrification, A. W. Cooper, Soil Conservation Service research engineer, W. O. Cochran, Jr., Alabama Power Co., and Henry Jackson, an Alabama seedsman.

The speaker at the luncheon was Charles M. Haasl, John Deere branch manager of Chamblee, Ga., who discussed the function of a farm machinery company trainee program. Among those attending the luncheon were Dr. Ralph B. Draughon, president; Dr. D. W. Mullins, executive vice-president, and Dr. E. V. Smith, associate dean and director of agriculture, Alabama Polytechnic Institute; Harold Schudt, general manager, Allis-Chalmers Mfg. Co., Gadsden, Ala., and E. C. Easter, vice-president, Alabama Power Co.

The afternoon period was devoted to a tour of the API agricultural engineering farm. Facilities inspected included the grain bin area with its thirteen bins of various materials and designs, the labor cottage design experiment which will make use of functional walls, and the irrigation tests showing methods and results. Also, a class of agricultural engineering students demonstrated the method used in teaching students farm machinery at API.

At an informal session, a "skill contest" was staged and conducted by members of the Alabama Student Branch ASAE, in which so-called "expert tractor drivers" of the Alabama Section were given the chance to perform. Tests of skill were driving tractors forward and backwards, with various items of mounted and drawn equipment, through a winding course in a given time without disturbing the stakes outlining the course.

The meeting closed with a barbecue, during which an award, including a one-year subscription to AGRICULTURAL ENGINEERING was presented to John Martin, the outstanding freshman in the agricultural engineering course at API during 1950. It was also announced that the three highest 1950 scholastic averages in the school of agriculture were made by agricultural engineering students.

(News continued on page 626)

A.S.A.E. Meetings Calendar

December 18-20 — WINTER MEETING, The Stevens, Chicago, Ill.

January 26 and 27—PACIFIC COAST SECTION, Mayflower Hotel, Los Angeles, Calif.

February 5-7 — SOUTHEAST SECTION, Peabody Hotel, Memphis, Tenn.

March 23 and 24—SOUTHWEST SECTION, Texarkana, Tex.

June 18-20 — ANNUAL MEETING, Rice Hotel, Houston, Tex.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to A.S.A.E., St. Joseph, Michigan

Two groups attending the ASAE Alabama Section meeting at Auburn, October 27 and 28. Left view (left to right): J. B. Wilson, chairman, Alabama Section; Dr. E. G. McKibben, principal engineer, U.S. Tillage Machinery Laboratory; Dr. R. B. Draughon, president, Alabama Polytechnic Institute; Dr. D. W. Mullins, executive vice-president, API; F. A. Kummer, head, agricultural engineering dept., API. Right view (left to right): C. M. Haasl, branch manager, John Deere Plow Co., Chamblee, Ga.; M. B. Penn, agricultural engineer, Alabama Power Co.; Dr. E. V. Smith, associate dean and director of agriculture, API; Harold Schudt, general manager, Allis-Chalmers Mfg. Co., Gadsden, Ala.; F. A. Kummer; Floyd Johnson, president, Alabama Student Branch of ASAE

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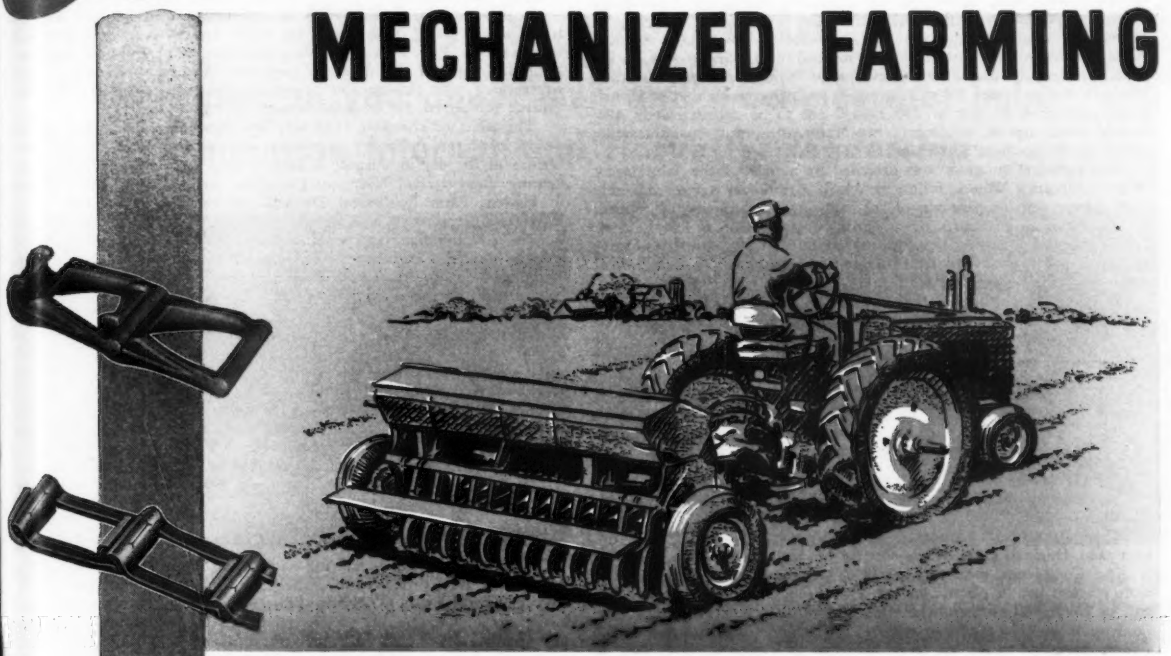

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CHAINS AND SPROCKETS

NEWS SECTION *(Continued from page 624)*

Waterloo Engineers Host to Iowa-Illinois Section

THE Iowa-Illinois Section of the American Society of Agricultural Engineers, jointly with local sections of the American Society of Mechanical Engineers and the American Society of Metals, and the Waterloo Technical Society met at Waterloo, Iowa, November 8, as the guests of the John Deere Waterloo Tractor Works. A most interesting program was arranged for this meeting, with the result that an anticipated attendance of 200 to 250 turned out to be approximately 400, largely made up of engineers from farm equipment manufacturing plants in the northern Mississippi Valley area.

The technical program was preceded by a tour of the John Deere Waterloo Tractor Works, following which a technical session was held with three papers by members of the company's engineering department as follows: Localized surface hardening by L. W. Steege, chief metallurgist; the John Deere "Power-Trol" by Stanley M. Madill, executive engineer; and use of SR-4 strain gages in development of farm implements by J. K. Jensen, engineer.

Following a chicken dinner at the John Deere Supervisors' Clubhouse, the manager of the clubhouse gave a short, interesting talk on its operation which was followed by a talk by R. R. Gager, plant engineer, on the design and construction of the clubhouse. The final number on the program was a most interesting paper on the economic evaluation of farm tractors fuels by Wayne H. Worthington, director of research.

National Farm Electrification Conference

WHAT are the problems in farm electrification and what should be done about them was the theme of the 5th National Farm Electrification Conference held in St. Louis, Mo., October 18-20. A sizeable group of agricultural engineers were represented in the 180 registrants who came from all parts of the country for the three-day meeting.

The Conference concerned itself chiefly with the utilization and more efficient use of electric energy. Some states lack less than one per cent of having all of their farms supplied with electric power, but the Conference reemphasized that there is a vast difference between having a farm connected to electric power and having it electrified. In fact, it was pointed out that there is not one farm in the nation that is completely electrified today.

The following ASAE members contributed to the Conference program: A. H. Hemker was program chairman, O. C. French pointed out what farmer problems are still unsolved, and R. H. Ricketts took part in a panel discussion on farm problems. J. C. Cahill presented a paper on complete electric house heating, and T. E. Hienton, Hobart Beresford and H. S. Hinrichs took part in a panel discussion on research problems and what is being done about them. Mr. Beresford also participated in a symposium with R. R. McBeth on testing and proving new products. P. T. Montfort was chairman of a panel discussion on meeting the problems of education and promotion, in which E. T. Swink, G. E. Henderson, R. M. Peart, and Nolan Mitchell also took part.

New officers of the Conference elected for the ensuing year are: Chairman, L. L. Rummell, dean of agriculture, Ohio State University, and vice-chairman, R. H. Reed, editor, *Country Gentlemen*. R. J. Gingles, manager, NEMA Farm Electrification Bureau, and K. H. Gorham, business manager, *Electricity-on-the-Farm,* will continue to serve as secretary and treasurer, respectively. New counselors, formerly known as regional vice-chairmen, include such well-known agricultural engineers as C. E. Seitz, G. E. Henderson, E. C. Easter, and J. C. Cahill. The 1951 Conference will be held in Cincinnati, Ohio, probably on October 9 and 10.

15 ECPD Accredited A-E Curriculums

IT WILL be of special interest to agricultural engineers generally to learn that the 18th annual report, for the year ending September 30, 1950, of the Engineers' Council for Professional Development (ECPD) will list a total of 15 professional agricultural engineering curriculums that have now received formal ECPD accreditation.

Until this report was issued, the total was five curriculums accredited by ECPD at the following schools: University of California, Iowa State College, Kansas State College, University of Nebraska, and Oregon State College. The ten schools whose agricultural engineering curriculums have been accredited in 1950 are as follows: University of Idaho, University of Illinois, Louisiana State University, Michigan State College, University of Minnesota, Oklahoma A. & M. College, Purdue University, A. & M. College of Texas, Utah State Agricultural College, and State College of Washington.

This achievement represents an important milestone in the efforts of agricultural engineering departments of land-grant colleges and universities to offer curriculums that meet the requirements of the schools of agriculture, from which the departments derive most of their financial support, and at the same time satisfy the schools of engineering as to engineering subjects. *(Continued on page 628)*

Michigan Section Fall Meeting

AN INTERESTING program was presented by the Michigan Area Section of the American Society of Agricultural Engineers at its first meeting of the 1950-51 season held on the Michigan State College campus, November 18.

A paper on the fundamentals of trilevel house design and the features which make it desirable for farm homes were described and illustrated by T. J. Brevik, assistant professor of agricultural engineering, MSC, opened the forenoon program. A tour of the large, new refrigerated food storage and preparation building of Michigan State College completed the forenoon session.

The effect of changing farm size and increased productivity on the design of farm machinery was very ably presented in the program feature of the day by Russell R. Raney, chief engineer, advanced engineering, International Harvester Company. In a talk, entitled "Trends in Modern Farm Equipment Design," he explained the effect of an increase in very small and very large farms. Some machines like the mower and combine can be sized down to meet the needs of the smaller farmer, but others like the corn picker are not so flexible. Equipment for special crops of limited production can be profitable, but require careful analysis, cost control, and use of flexible dies and flat stock. T. A. Curtis, a graduate student in agricultural engineering, described a method and equipment he has developed for low-temperature concentration of juices from Michigan fruits and vegetables. Results and taste tests indicate that concentrated apple and crab-apple juices are very promising. While it is often difficult to convince farmers that you can heat a milkhouse with cold water, W. F. Buchinger, farm service engineer, Detroit Edison Co., had little trouble selling the idea to his fellow agricultural engineers in a talk on the milk cooler as a heat pump. He discussed the equipment needed to make the conversion and pointed out that it is very efficient and reasonable in operating costs.

Washington Section Program on Processing

AT ITS regular monthly meeting on October 13, the Washington, D.C., Section of the American Society of Agricultural Engineers was addressed by Harold D. White, professor of agricultural engineering, University of Georgia, on various phases of the mechanical processing of agricultural products in rural communities, including locker plant studies in layout and design, fence post peeling and treatment, bean and pea hullers, and canning in glass—all high lights of the challenge to agricultural engineers for work in this field.

About 50 ASAE members and visitors were in attendance at the meeting. W. M. Hurst, senior agricultural engineer, division of mechanical processing of farm products (BPISAE) U.S. Department of Agriculture, presided as program chairman for the meeting. His definition of the field of mechanical processing and the types and locations of various phases of this work brought into prospective the work reported on by Professor White.

Pennsylvania Section Elects Burress

CHARLES G. BURRESS, extension agricultural engineer, Pennsylvania State College, was elected chairman of the Pennsylvania Section of the American Society of Agricultural Engineers at the fall meeting of the Section at Lancaster, Pa., October 20 and 21. Jack S. Slusser, assistant manager, farm utilization dept., Pennsylvania Power and Light Co., was elected the new vice-chairman of the Section, and Harold V. Walton, instructor in agricultural engineering, Pennsylvania State College, the new secretary-treasurer.

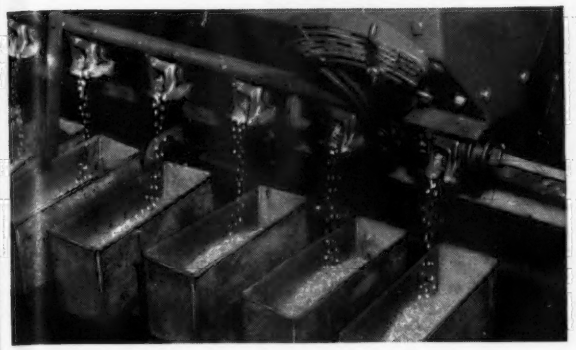
The new nominating committee of the Section consists of L. S. Singley, (chairman), A. R. Hunsicker, and A. S. Mowery.

A total of 79 members and non-members of ASAE attended the meeting of the Section, one of the high lights of which was the tour of the factory of the New Holland Machine Co., a division of The Sperry Corp., at New Holland. *(News continued on page 628)*

A portion of the group attending the fall meeting of the ASAE Pennsylvania Section viewing the assembly of a New Holland baler

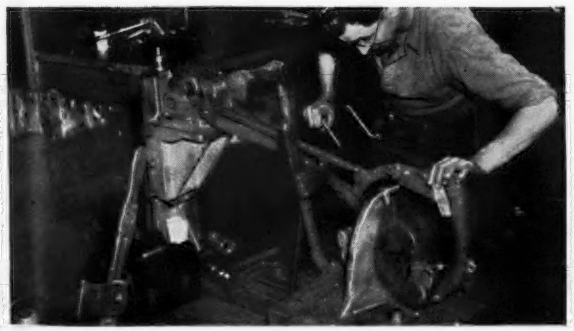
How 700 Factory Tests help keep *McCormick Drills* "First in the Field"

A report to you about men and machines that help maintain International Harvester leadership



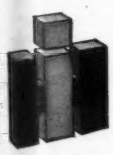
Seeding test makes drills prove accuracy. See the wheat these fluted feeds are measuring into individual boxes. It's carefully weighed to make sure all feeds sow uniform quantities of grain. The total weight of this grain must check with seed index settings. This is one of over 700 tests and inspections that safeguard the dependable field performance of McCormick grain drills.

Feeds are checked 14 different ways. Here are the gauges that IH inspectors use to insure peas-in-the-pod sameness of McCormick fluted feeds. The feed cup, fluted roll, shut-off block, and dump bottom are individually checked. Every fluted feed must pass this tough 14-point inspection. This is in addition to many visual inspections at every step of manufacture.



Openers must be perfectly aligned. Single-disk openers are assembled on a fixture that holds all parts in proper relationship. Undercut and angle of draw are built into each assembly. No further adjustment is needed in the field. Three gauge points provide visual proof of perfect opener alignment. All gauges that uphold IH standards are frequently measured against master gauges.

Three thousandths of an inch is too much! Here is a workman measuring the diameter of a wheel hub. It can't vary more than two thousandths of an inch from IH standards. Rigid inspections like this constantly measure quality, but good workmanship maintains it. This pride in a job well done has made the IH trademark a symbol of *extra* value for over a century.



INTERNATIONAL HARVESTER Chicago 1, Illinois

International Harvester Builds McCormick Farm Equipment and Farmall Tractors ... Motor Trucks ... Crawler Tractors and Power Units ... Refrigerators and Home Freezers ...

NEWS SECTION *(Continued from page 626)*

Robert P. Messenger Advanced

ROBERT P. MESSENGER, formerly vice-president in charge of foreign operations of the International Harvester Co., became executive vice-president of the Company on November first.

Mr. Messenger was born in England, brought to this country at an early age, and in 1910 became an employee of the Springfield Works of the Harvester Co., as a mechanical draftsman. He went to Europe in 1913 when the Company's first foreign engineering department was organized there. When the Brussels office was reopened after World War I he was given charge of the engineering and patent departments thre, becoming a member of the Brussels conference. He remained at Brussels as inspector-general of engineering until 1938, when he was transferred to Australia as chairman of the board of directors of the International Harvester Co. of Australia.

Six years later Mr. Messenger returned to the United States to become assistant to the vice-president in charge of engineering. His special assignment was farm implement engineering. When the Company's farm implement division was formed in February, 1944,, he was named the first general manager of the division. He became a vice-president of the Company in March, 1945. Two years later he became vice-president of the foreign operations organization, and has held that position since.

Regional Extension Cotton Conferences

AGRICULTURAL engineers had a prominent part in three regional extension conferences on cotton production held during October. They were planning meetings to set the stage for helping cotton growers meet a 16-million-bale production goal for 1951. Each was a two-day meeting. They were held at Columbia, S. C., Texarkana, Ark., and Memphis, Tenn.

In a summary report and recommendations resulting from the three conferences, it is recognized that considerably increased yield per acre as well as additional acreage will be needed to achieve the goal; that the program should involve little or no interference to balanced farming, diversification, and soil conservation; and that state and county cotton committees should estimate their maximum cotton production opportunity under these conditions, and report their requirements for fertilizer, insecticides, machinery, other materials, and labor to meet their production goals.

Agricultural engineering objectives for mechanization and ginning contributions to the program include having engineering serve farm management, agronomic, soil management, pest control, and marketing requirements; having approved agricultural engineering practices incorporated in regional, state and county programs; providing adequate supplies of machinery and materials for production, harvesting, and ginning; and having existing farm machinery repaired, reconditioned, protected and operated in ways that will make it most productive and useful in 1951. Basic principles and procedures for meeting these objectives are also named in the report.

ASIEM Elects New Officers

AT THE two-day meeting, November 10 and 11, held at Phoenix, Ariz., the Association of Sprinkler Irrigation Equipment Manufacturers elected the following officers for the ensuing year: President, Crawford Reid, engineer and sales manager, Rainbird Sprinkler Mfg. Corp.; vice-president M. H. A. Miller, secretary and production manager, Anderson-Miller & Posten Mfg. Co., and secretary-treasurer R. M. Morgan, manager, irrigation div., R. M. Wade & Co.

Attendance at the meeting represented manufacturers of the four essential kinds of equipment required in sprinkler irrigation, namely, sprinklers, pumps and engines, pipe, and coupling fittings.

The headquarters address of the ASIEM will be the office of the secretary-treasurer, 106 S. E. Hawthorne Blvd., Portland, Ore.

IHC Studied by Educators

HENRY J. BARRE and Floyd W. Duffee, heads of the agricultural engineering departments at Purdue University and the University of Wisconsin, respectively, participated in an industry seminar sponsored by the International Harvester Company last summer and recently reported in *Harvester World*.

They were two of eleven educators from ten universities who were given complete freedom and encouragement to study any and every aspect of the Company's policies, methods, and operations for a three-week period.

Other educators present represented the fields of accounting, agricultural economics, business management, economic geography, economics, marketing, political science, sociology, and transportation. They were selected for the assignment by the heads of the schools invited to send representatives.

George W. Kable Passes Away

GEORGE W. KABLE, 1888-1950

GEORGE W. KABLE, editor of *Electricity on the Farm* magazine, passed away November 7, at the age of 62. He had been a member of the ASAE since 1914, was its president for the year 1941-42, and was elected a Life Fellow in June, 1949.

George Kable will be remembered as a congenial gentleman whose personality, engineering ability, and keen foresight as to the possibilities of rural electrification made him a prominent leader in this field from its earliest days up to the present. His professional equipment was notably an inquiring, perceptive, well-educated mind balanced by an uncommon fund of common sense.

Born at Shannon, Illinois, he graduated from the North Dixon High School in 1906. For his professional training he went first to the University of Washington, where he studied civil engineering for 3½ years, then to the University of California for 1½ years in irrigation engineering. He received his bachelor's degree in civil engineering there in 1914. At that time he was already at the New Mexico College of Agriculture, teaching and making a further study of agriculture. Later study qualified him for a master's degree in agricultural engineering, awarded by the University of Nebraska in 1922.

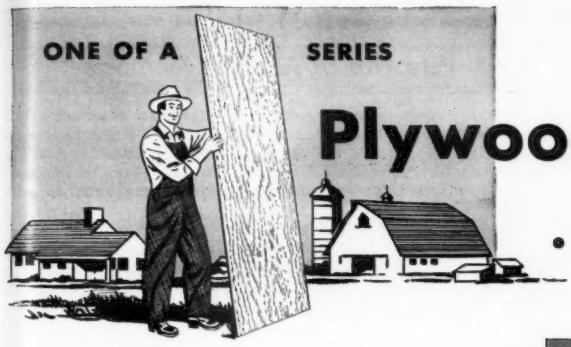
A broad background of early professional work helped to qualify him for his later preeminence in rural electrification. It ranged from student vacation work on boundary surveys in Alaska and part-time teaching, to railway terminal engineering in Chicago, landscape gardening and irrigation surveys in California, work on steam generating and hydroelectric plant construction in California, irrigation farming in New Mexico, inspection of paving in San Francisco, engineering drafting for the Port of Seattle, research in irrigation in New Mexico, water measurement work on an irrigation water supply project, county agricultural agent work in Oregon, and extension agricultural engineering work in drainage and land clearing, also in Oregon.

His direct association with rural electrification began in 1925 when he was employed as agricultural engineer at the Oregon Agricultural Experiment Station and director of the Oregon Committee on the Relation of Electricity to Agriculture. While there, in the spring of 1928, he also served as consulting engineer for the Portland Electric Power Co., preparing a plan for the development of rural electric service in its territory. In November, 1928, he moved east to become director of the National Rural Electric Project at College Park, Md.

From 1929 to 1934 he was also director of research for the National Committee on the Relation of Electricity to Agriculture (CREA). Later he directed a survey of rural electrification in the United States for the Civil Works Administration, made a special study and report on rural electrification in Tennessee, and from 1934 to 1937 was chief of the rural electrification and agricultural engineering division of the TVA. He had been editor of *Electricity on the Farm* since 1937.

During this time he was one of the organizers and early chairmen (1931-32) of the Rural Electric Division of ASAE, and active in its committee work. While specializing in rural electrification, he retained a strong interest in the whole field of agricultural engineering. In the Society he cheerfully accepted and carried out responsibilities related to its general administration as well as those directly concerned with his particular interest in rural electrification.

He was also a Mason, member of the American Association for the Advancement of Science, and a member of Gamma Sigma Delta. He is survived by his widow, Florence Kopan Kable, and a son, Kelvin Duane Kable.



Plywood on the Farm

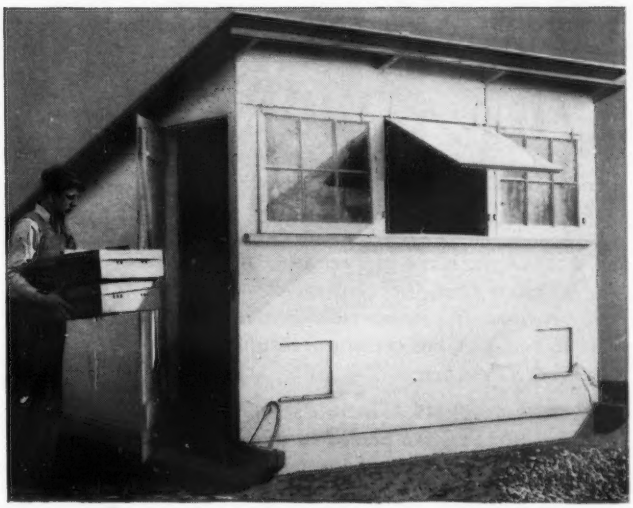
...for Poultry Houses

EXTERIOR-TYPE Douglas fir plywood—the real wood panel material with completely waterproof bond—makes possible the construction of poultry houses which are tight, dry, strong and rigid...yet light in weight and easily moved.

With plywood construction, there are no open joints or cracks to permit air infiltration or provide a harbor for pests and disease germs. This tightness not only keeps out drafts, but also permits ventilation systems to work to best advantage.

Glued construction adds to the tightness of a plywood structure and at the same time increases both structural rigidity and durability. It doubles the average life of portable brooder houses which are moved over uneven ground. (For gluing data, see page 6 of booklet offered below). Plywood fastened with nails, screws or bolts offers an exceptional serviceability factor, too, although not as great as with gluing. The large panels speed construction and are definitely preferred for prefabricated structures.

Exterior plywood has been used for years as roofs, walls, ceilings, floors, nests and feed hoppers in poultry houses.



▲ This sturdy brooder house was built and tested at the Purdue Agricultural Experiment Station. Plywood approximately one-half the thickness of corresponding matched lumber produced a structure more rigid but only two-thirds as heavy.

Plywood, like any wood, possesses excellent insulating properties—of particular importance in poultry house construction. ▼

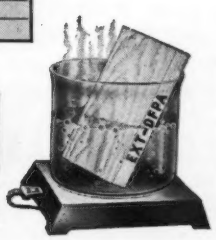
INSULATION VALUES DOUGLAS FIR PLYWOOD			Total Resistance (Inside to Outside Air)	U-Coefficient of Thermal Transmission in B.T.U.'s/hr./sq. ft./°temp. difference
WALL CONSTRUCTION				
⅜" Plywood, single sheet			1.26	.79
¾" Plywood, single sheet			1.74	.58
½" Fibre board, single sheet			2.17	.46
Inside Lining	Insulation Between Studs	Outer Wall Materials		
¼" Plywood	None	⅜" Ext. Plywood	2.49	.40
¾" Plywood	None	⅜" Ext. Plywood	2.65	.38
¼" Plywood	½" Blanket Insul.	⅜" Ext. Plywood	5.40	.19

Get This Booklet

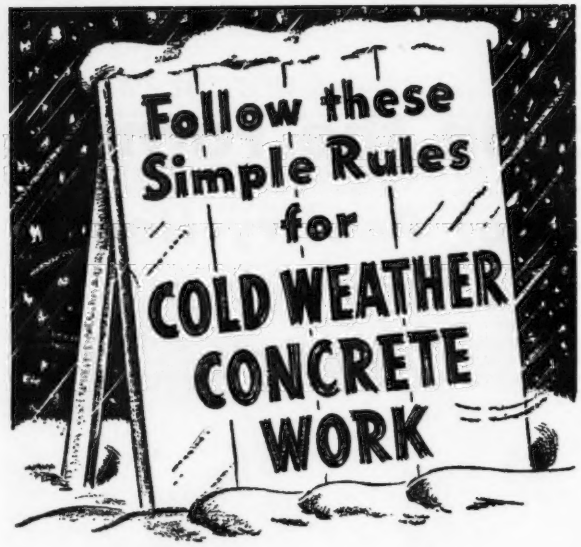
Information on Exterior plywood for farm uses available in this 28-page booklet. Also a list of tested plans for plywood farm structures, available from leading agricultural colleges. Write Douglas Fir Plywood Association, Tacoma 2, Washington or Albert E. Powell, Agricultural Engineer, P. O. Box 32, Ames, Iowa.

***Exterior Type Douglas Fir Plywood**

Can Be Boiled in Water—A Test Far More Severe Than Years of Weathering!



Only Exterior-type Douglas fir plywood—bonded with completely waterproof phenolic resin adhesive—should be used for farm service structures. The EXT-DFPA grade-trademark on the panel edge is your positive identification.



AFTER the last crops are in farmers usually have more time for construction work. Concrete improvements can be built in winter just as well as in summer, but certain precautions must be observed. These are:

1. **HEAT MATERIALS.** Concrete should be between 60° and 80° F. when placed in the forms. Heat sand and coarse aggregates separately until all frost, ice or snow disappears. The water should never be hotter than 175° F. when it comes in contact with the portland cement in the mix—otherwise a flash set may result.

   In above-freezing weather heating the water or putting a heater on the mixer may be all that's necessary to bring up the temperature of the mix.

2. **MIX CAREFULLY** so that concrete is as stiff as possible and yet will place and finish properly. Never add salts or chemicals to *prevent freezing*. Small amounts of calcium chloride (2 lb. per sack of cement) may be used to *accelerate the hardening*.

3. **CLEAN FORMS** of all frost, ice and snow.

4. **THAW GROUND** if it is frozen. Never place freshly mixed concrete on frozen ground.

5. **PROTECT CONCRETE FROM FREEZING.** Flat work can be protected with heavy paper and 10 to 12 in. of hay or straw. Walls and other structural members must be enclosed with canvas and kept warm. Do not remove forms until concrete has had time to harden properly. Normally concrete must be maintained at 50° F. or higher for five days after placing. However, with high-early-strength concrete this time period may be reduced.

PORTLAND CEMENT ASSOCIATION

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A national organization to improve and extend the uses of portland cement and concrete...through scientific research and engineering field work

Personals of A.S.A.E. Members

Jesse B. Brooks, assistant professor of agricultural engineering, University of Kentucky, has the distinction of being the first agricultural engineer in the state to be registered with the Kentucky Board of Registration for Professional Engineers. Two years ago the Kentucky board set up the classification for agricultural engineers, and Mr. Brooks was registered on the basis of passing a written examination and 8 years' experience in the field.

Battle B. Ewing, agricultural engineer, Agricultural Research Administration, U. S. Department of Agriculture, was recently transferred from the U. S. Cotton Ginning Laboratory at Stoneville, Miss., to the Cotton Mechanization Project at Shafter, Calif. His address there is Route 1, Box 17.

George T. Hardy is now manager of the Wallace E. Johnson Nurseries, Memphis, Tenn. Previously he was nursery and greenhouse inspector with the Tennessee State Department of Agriculture.

Francis J. Hassler, who was recently awarded the Ph.D. degree in agricultural engineering at Michigan State College, recently joined the staff of the agricultural engineering department of North Carolina State College as research assistant professor. His work will have to do with the grading of the tobacco leaf.

Curtis A. Johnson is currently on leave from his position as principal of Friendsville Academy, Friendsville, Tenn., and is taking graduate work in farm structures at Iowa State College.

Robert E. Kyle, recently joined the New Idea Co. at Coldwater, Ohio, as project engineer. He was formerly junior engineer at the South Bend plant of The Oliver Corp.

George B. Nutt, head, agricultural engineering department, Clemson Agricultural College, is temporarily on leave from his regular duties to serve as a consultant to the International Bank for Reconstruction and Development. He left for Iraq on October 29, the purpose of the mission being to make technical and economic studies of the agricultural equipment and grain storage projects proposed as a basis for a loan to Iraq.

Minnesota Section News

THE Minnesota Section of the American Society of Agricultural Engineers held a dinner and ladies' night meeting at the Curtiss Hotel in Minneapolis on Tuesday evening, November 28. A feature of the program was a colored motion picture, entitled "Around South America", with Virginia Safford, Minneapolis columnist, as the narrator. The picture was the result of two trips to South America and included tours of seven countries on that continent. A special invitation was extended to ASAE members in North and South Dakota to attend the meeting.

Henry Ford Memorial Award

THE Detroit Section of the Society of Automotive Engineers recently announced the "Henry Ford Memorial Award" to be presented annually for the encouragement of young engineers in the automotive field. It commemorates the interest in young engineers shown by Mr. Ford throughout his lifetime.

Eligibility for the award has been limited to members of the Society of Automotive Engineers under 33 years of age.

Necrology

ELMER FIELD CLARK, sales engineer in the farm equipment division of the Butler Mfg. Co., passed away November 19 at Independence, Mo. A native of Kansas, Mr. Clark earned his bachelor's degree in agricultural engineering at Kansas State College in 1932, and his master's degree at Iowa State College the following year, majoring in farm structures. Following his graduation he spent several years in soil conservation work in progressively responsible capacities. Since 1942 he had been associated with the Butler Mfg. Co., in the design, development, and sale of buildings, bins, tanks, tank heaters, feeders, and related items. He was a member of Acacia Fraternity and of the First Presbyterian Church of Independence. He is survived by his widow, Miriam L. Clark; a daughter, Marilyn; his parents, Mr. and Mrs. E. B. Clark, Jewell, Kansas; and two brothers, Otis E. Clark, of Jewell, and Dr. F. W. Clark, Holton, Kansas.

• • •

WARNER M. HELD, 56, head engineer of the Chicago Office of New Departure, Division of General Motors Corporation, died Monday, November 20, in Mercy Hospital, Chicago. Intimately associated with the farm implement people for a quarter of a century and recognized as an authority on anti-friction bearing application, Mr. Held joined New Departure in 1924. He was with Advance-Rumely and Samson Tractor prior to that time. Born in LaPorte, Indiana, he was buried there on Friday, November 24, 1950. Surviving are a daughter, Mrs. Shirley Tufteland, and two sons, Richard and Thomas.

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Soil Conservation is your concern and ours

Your job and the jobs of everyone who sells to farmers depend on a prosperous agriculture. That's why American Steel and Wire Company has taken an active part in promoting soil conservation. You, too, can help by urging farmers to put soil conservation plans into immediate operation wherever they are feasible.

HOW FENCE AND WIRE PRODUCTS FIT INTO THE PROGRAM

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offers the best means available for keeping livestock under control. Livestock should be excluded from wood lots, ponds and erosion-scarred areas that are being revegetated. In pastured areas, fence is an important TOOL OF FARM PRODUCTION that enables livestock to harvest their own feed.

AMERICAN WIRE FABRIC

is an excellent reinforcement for concrete dams, flumes, spillways and irrigation ditches.

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is used on earth-moving equipment, for hoists, tow ropes and other applications around the farm.

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are used for REA lines and offer a type of cable for every farm use. Special rubber-covered cables are designed for underground use to distant wells and pumps.

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USS

UNITED STATES STEEL

NEW BOOKS

IRRIGATION PRINCIPLES AND PRACTICES, by Orson W. Israelsen. Second edition. Cloth, xii + 405 pages, 6 x 9¼ inches. Illustrated and indexed. John Wiley and Sons, Inc. (New York 16, N. Y.) and Chapman and Hall, Ltd. (London). $6.00.

This professional level text and reference in the Wiley Agricultural Engineering Series edited by J. Brownlee Davidson is brought up to date with new data reflecting progress in various phases of the subject, and some shifting of emphasis to suit the growing importance of certain divisions of the subject matter. A chapter on drainage of irrigated lands has been added. Chapter 14 on consumptive use of water was prepared by Harry F. Blaney, and Chapter 18, on social and administration aspects of irrigation, by J. Howard Maughan. In order of presentation chapters cover progress and problems; sources and storage of irrigation water; measurement of irrigation water; conveyance of irrigation water; pumping water for irrigation; irrigation methods; farm irrigation implements and structures; basic soil and water relations; storage of water in unsaturated soils; the flow of water in soils, saline and alkali soils; drainage of irrigated lands; time of irrigation; consumptive use of water; irrigation of cereals, forage, and root crops; irrigation of orchards; irrigation in humid climates; and social and administrative aspects of irrigation.

ELECTRICITY IN THE HOME AND ON THE FARM, by Forrest B. Wright. Third edition. Cloth, xvi + 380 pages, 5½ x 8 inches. Illustrated and indexed. John Wiley and Sons, Inc., (New York 16, N. Y.) and Chapman and Hall, Ltd., (London). $3.96.

This established vocational text and reference has been brought up to date by replacing the elementary material in previous editions with more advanced information. Material on low-voltage wiring and equipment has been largely supplanted with increased attention to alternating current and standard voltage equipment.

Part I on principles and applications of electricity includes chapters on importance of electricity to the farm business and to the farm home, the nature of electricity, electric circuits, electrical terms and measurements, magnetism, electrical effects, electromagnetic induction and some of its applications, alternating current, power-generating, transmission and distribution systems for alternating current, wiring systems for the farm and for the home, planning a wiring system, and electric motors.

Part II on jobs and study activities provides lessons on series circuits, parallel circuits, doorbell circuits, snap switches, low-voltage relay switching controls, special switches, fuses and circuit breakers, materials used for conductors and insulators, wire conductors, splices, splicing devices, extension cords, heater cords, meter reading and bill computing, watthour meters, wiring systems, voltage losses, effect of voltage drop, economics of line losses, wire sizes for circuits, service entrances, property load centers, outlets and fixtures, and electric motors.

FARM WATER MANAGEMENT, by J. C. Wooley and R. P. Beasley. Cloth, 170 pages, 5 x 8 inches. Illustrated and indexed. Lucas Bros. and the Missouri Store Co. (Columbia) $3.25. (Accompanying Problem Set, paper, 15 problems, 8½ x 11 inches. 50 cents).

This is a condensed reference and text on water management for farm use. Chapters cover selecting management practices, measuring distances, measuring and laying out angles, computing areas, the farm level, topographic maps and their use, topographic mapping, rainfall and runoff, terraces, terrace outlets, diversion channels, overall structures, ponds, contour farming and strip cropping, and planning water management systems.

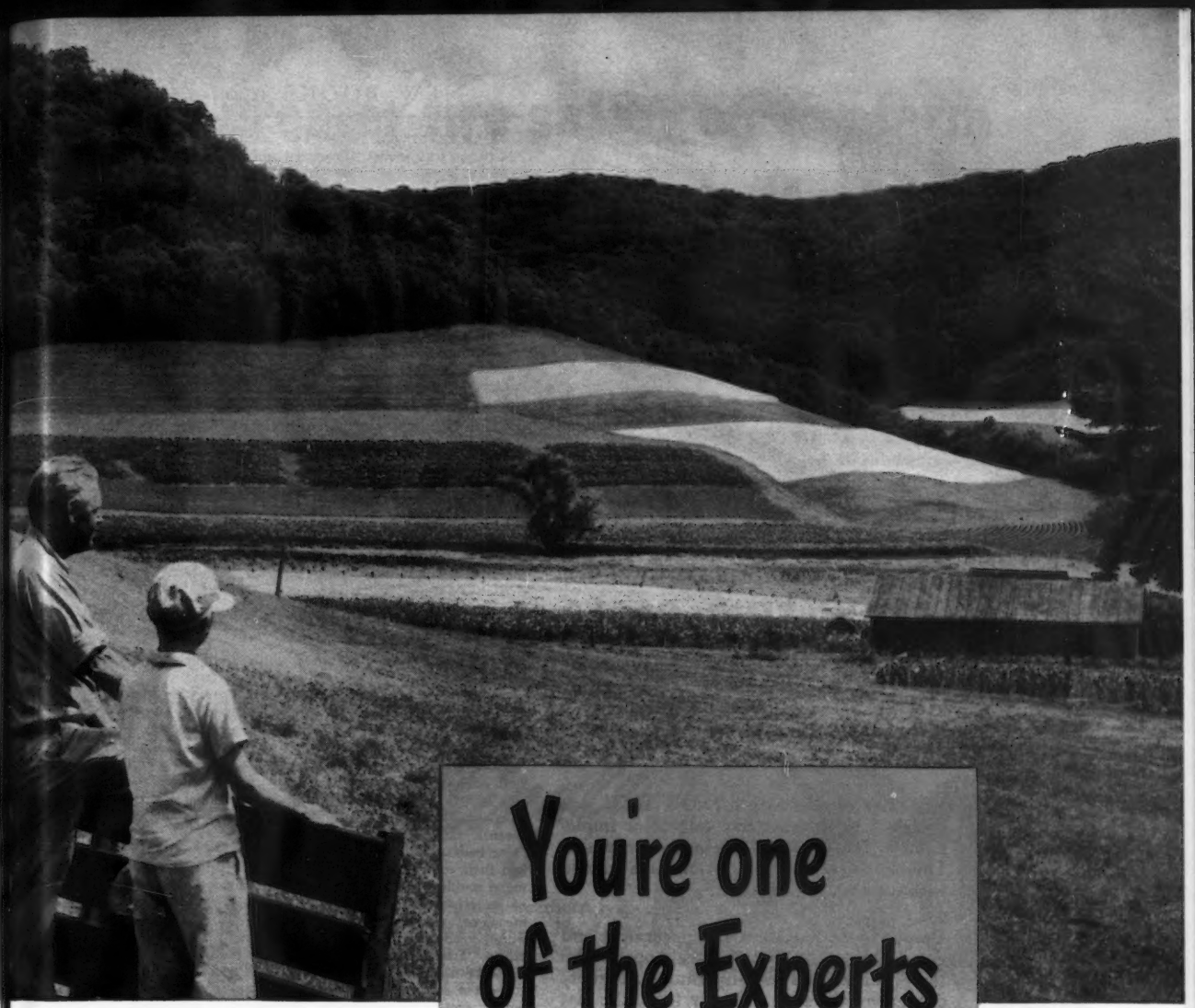
PROGRESS AND ECONOMIC PROBLEMS IN FARM MECHANIZATION, prepared by A. M. Acock. Paper, 88 pages, 6 x 9 in. Indexed and illustrated. Food and Agriculture Organization of the United Nations, Washington, D.C. (September, 1950), $1.

This report brings together for the first time information on progress in the manufacture and utilization of farm machinery and equipment, and on world trade in these products. It reviews the trends and examines some of the complex economic problems associated with raising the level of farm mechanization throughout the world. It is offered for the use of government officials, agricultural engineers, and others interested in improving the standard of farm equipment in their respective countries and in developing programs suited to local conditions.

Animal and mechanical power is compared in world agriculture and regional aspects of farm mechanization are given for North America, Europe, Russia, Latin America, Near East, Far East, Africa, and Oceania.

SAE HANDBOOK (1950 edition). Cloth, ixiv + 1082 pages, 5½x8 inches. Illustrated and indexed. Society of Automotive Engineers (New York 18, N. Y.)

New specifications in this edition cover carbon steel bars, cigar lighter switch bases, helical compression springs, helical compression and extension springs, methods of measuring case depth, and radiator nomenclature. There are revised specifications under the general headings of aeronautics, lighting, materials, parts, and tests. Among the new specifications, one on screw threads conforms with the Unified Screw Threads recently agreed upon by the United Kingdom, Canada, and the United States, and covered by American Standard B1.1—1949.



You're one of the Experts

behind this Soil Conservation picture

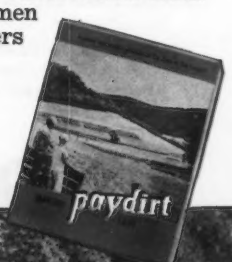
The farmer and his son did the work. The soil conservation service helped them make the plan. Perhaps a local bank financed the operation. But the farm equipment engineer was one of the experts, too.

For only with modern power equipment, rightly used, is conservation farming practical and profitable. "Today we switch to conservation farming because it means a bigger income," declared a soils specialist recently. And experience has proved that farmers will "stay switched" only if conservation farming is made profitable.

That makes it a job — and a challenge — for every agricultural engineer. If soil conservation is to progress, farm machines must fit this kind of modern farming. And each farmer-owner must be properly instructed in the right use of each implement.

That's why Allis-Chalmers dealers have been supplied with a new soil conservation handbook, "Making Paydirt Last." It looks at soil management from the farmer's side of the fence — detailing specific practices for cropland, grassland and woodlot, illustrating them with photos and sketches.

In company with county agents, vocational agriculture instructors and soil conservation farm planners, farm machinery men have become recognized partners in the promotion of better farming.



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TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

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Pat. No. 2432554 other patent pending

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MOST ADAPTABLE SEAT IN THE INDUSTRY!

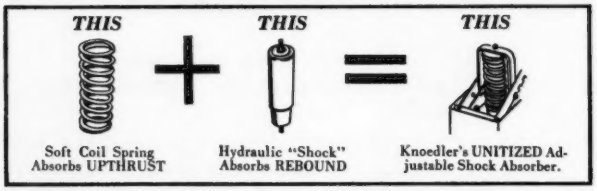
15 versions of the famous FLOW-TING Spring Hydraulic Seat are now available to fit 95% of all tractor makes and models—as well as many self-propelled combines and earth-moving units.

SPECIFIC DESIGNS FOR ANY MACHINE

Knoedler can develop a FLOW-TING seat designed to fit most any tractor or implement — large or small, present or proposed. This engineering cooperation is available without cost or obligation.

BASED ON ONE PROVEN PRINCIPLE

Despite wide variation in appearance and construction, all Knoedler seats operate on the "unitized" spring-hydraulic assembly proven by the auto industry to be the last "ride control" principle so far developed. All models provide instant adjustment to "tailor" the ride to driver's weight or ground conditions.



SPRINGS ALONE AREN'T ENOUGH!

It takes *both* springs and hydraulic shock absorber action to provide effective ride control. The auto industry proved that years ago. Let us show you how the Knoedler seat can be adapted to any machine where an even "floating" ride—free from shock, "see-saw" or dumping action — can contribute to operator safety & health.

Knoedler's proven Ride-Control principle can be developed for any tractor or implement design, present or proposed. Speculative engineering help available at no obligation.

Phone or write for prices, prints or specifications.

Knoedler

KNOEDLER MANUFACTURERS, INC.
Dept. AE5 118 Iowa Ave. Streator, Ill.

NEW BOOKS *(Continued from page 632)*

FARM ELECTRICAL EQUIPMENT HANDBOOK, 1950. Leatherette bound, 224 pages, 6x9 inches. Illustrated and indexed. Edison Electric Institute (420 Lexington Ave., New York 17, N. Y.) $2.25, postpaid.

This handbook presents in simple, non-technical language, essential descriptions and illustrations of over 200 pieces of electrical farm equipment, its uses, purchase price range, cost of operation, and value in terms of increased farm profit. It also contains lists of manufacturers for each piece of equipment discussed and an extensive bibliography of over 450 publications dealing with the applications described.

Primarily designed as a practical working tool for rural service representatives and county extension workers in the broadening of the use of farm electrical equipment, vocational-agricultural teachers and students alike should find that the comprehensive coverage of the book makes it extremely useful as a text and a reference. Farm electrical equipment dealers should also find it valuable both as a sales stimulator and as a practical reference work.

This book was prepared under the sponsorship of the Utilization Committee of the Farm Section, Edison Electric Institute, from a master's thesis by Vernon H. Baker at Michigan State College. It was edited by C. N. Turner of Cornell University and published under the general supervision of a special advisory committee, composed of representatives of the U.S. Office of Education, U.S. Department of Agriculture, and the electric light and power industry.

KENT'S MECHANICAL ENGINEERS' HANDBOOK (12th edition). Separate volumes on *Power* edited by J. K. Salisbury and on *Design and Production,* edited by Colin Carmichael. Cloth, 1450 and 1660 pages, respectively, 5½x8½ inches. Illustrated and indexed. John Wiley and Sons (New York; Chapman and Hall, Ltd., London). Each volume, $8.50.

The *Design and Production* volume emphasizes these interests as related phases of a single activity, "the engineering of a product from the inception of an idea to the completion of the finished article at an economical cost." Its sections may be broadly grouped under selection of materials, design principles, design and selection of machine components, production processes, production plant equipment, and mathematical tables. Individual sections cover general properties of materials; iron and steel; corrosion and corrosion resistance; nonferrous metals and alloys; nonmetallic materials; fabricated materials; mechanism, mechanics, and machine elements; strength of materials; vibration and noise control; fasteners; mechanical springs; bearings and lubrication; machine hydraulics; gearing; mechanical power transmission; electric motors and their control; control mechanisms; machine components and testing; metal molding and casting processes; plastic working of metals; joining of materials; industrial heating processes; metal-cutting processes; dimensional control; working of non-metallic materials; materials handling; production plant construction and equipment; and mathematical tables. The *Power* volume covers the field of heat-power engineering and important related aspects of fluid flow. By groups, its sections cover the basic ingredients of any power process, service functions, power producing equipment, heat-moving equipment, transportation, electric power, and miscellaneous information. Individual sections cover air; combustion and fuels; heat and heat exchange; steam, water, and ice; hydrodynamics, hydraulics, and pumps; piping; steam-generating units; steam turbines and engines; condensers and cooling equipment; combustion gas turbines; refrigeration and ice making; heating, ventilating, and air conditioning; internal-combustion engines; land transportation; air and marine transportation; electric power; atomic power; instrumentation; power test codes and mathematical tables.

PLANS FOR MAKING FARM TOOLS AND EQUIPMENT. Paper, 32 pages, 5¾ x 8¾ inches. James F. Lincoln Arc Welding Foundation (Cleveland 1, Ohio). $0.25.

A reprint from the more extensive work, "Welding Helps for Farmers," by the same publisher, this booklet covers plans and suggestions for making 25 different shop and farm equipment items.

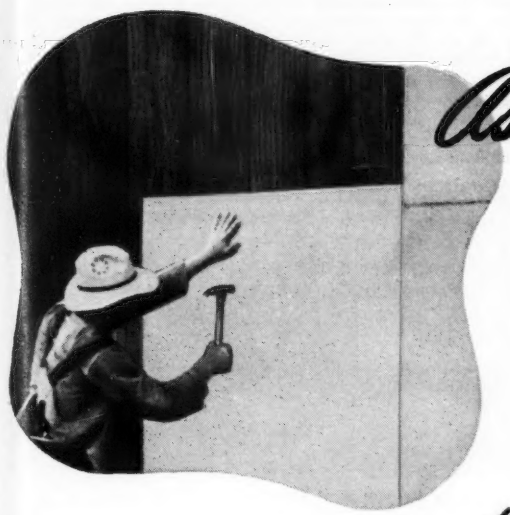
Electrification Grows

(Continued from page 599)

by agricultural engineers concerned with effective farm use of electric power.

Projected doubling of the farm use of electric power doubles the economic importance of improving the efficiency of its use, and of all farm operations in which it is used. It doubles the opportunity for agricultural engineers to be of value to agriculture in rural electrification research, extension, teaching, product and method development, sales, service, and any other ways of working which may be used in helping farmers to make the most of electricity as a servant. It suggests, not push-button farming, but additional realistic thinking toward making electrical controls the nerve system of farm yard operations.

For greater fire safety on the farm ...Johns-Manville Building Materials



Asbestos Flexboard*

STRONG AND TOUGH: Time-tested sheet material of asbestos and cement, can be used outdoors, indoors... is rodentproof, fireproof, sanitary. Saws and nails like wood, never needs preservative treatment. So flexible it can be used on curved surfaces.

Asbestos Shingles

—LAST 35 YEARS PLUS! Fireproof, rotproof, weatherproof. Thousands have already been in service 35 years. No signs they won't last another 35 years or more! New American Colonial design is the most beautiful ever developed. Easy to apply.

Super-Felt* Rock Wool

SUPERIOR INSULATION: Keeps farm building temperatures more uniform... helps produce more milk, more eggs, more weight per pound of feed. Easily installed, fits snugly, will not settle. And it's *fireproof* . . . you can't burn it even with a blow torch.

• • •

Other Johns-Manville building products for the farm include Smoothgrain Asbestos Siding Shingles, Insulating Board, Ceiling Panels and Wall Plank, Asphalt Shingles, Asphalt Roll Roofing, Roof Coatings and Putties. Write for our catalog of building materials. Johns-Manville, Farm Division, Box 290, New York 16, N. Y.

Reg. U. S. Pat. Off.

JOHNS-MANVILLE JM PRODUCTS

STOW flexible shaft

ON THE JOB FOR BELL TELEPHONE

BELL TELEPHONE CO. experts in rural line maintenance select their equipment for all-around, all-weather, on-the-job dependability. The above illustration shows a STOW Flexible Shaft transmitting power to one of the POST-HOLE DIGGERS used by BELL TELEPHONE CO. in maintaining rural power lines. STOW Flexible Shafting can solve your problems in power transmission. Write today for your handy STOW TORQUE CALCULATOR — and further information on unique applications of STOW FLEXIBLE SHAFTING!

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Learn how Stow Flexible Shafts have been solving power transmission problems since 1875.

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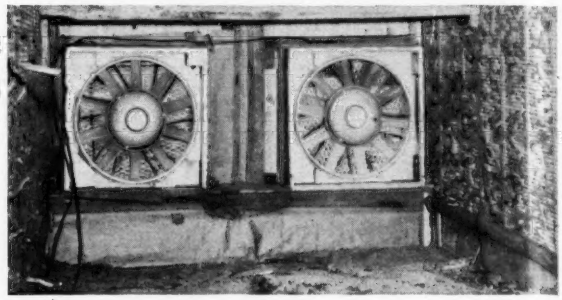
NEWS FROM ADVERTISERS

New Products and Literature Announced by AGRICULTURAL ENGINEERING Advertisers

Blood Bros. Countersunk Grease Fittings. Blood Brothers Machine Co., Allegan, Mich., announces an improvement in its tubular drive line assembly, in cooperation with the agricultural implement industry's continuing program to make power farm implements completely safe. Two Zerk fittings employed to lubricate the slip assembly have been redesigned and are now being countersunk flush with the surface of the shaft. Thus the shaft presents a smooth surface, practically eliminating the possibility of the operator's clothes becoming entangled with the rotating drive line.

• • •

Knoedler Crop-Drying Fan. Knoedler Manufacturers, Inc., Streator, Ill., announce a portable, weather-proofed crop-drying fan capable of delivering 20,000 cfm of air. Known as the Crop-Drier, it can be used to efficiently dry hay, ear corn, shelled corn, small grains and all forage

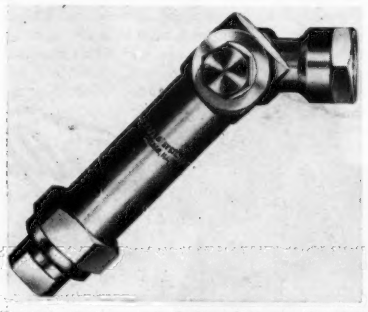


An installation of Knoedler crop-drying fans

crops and two units are shown in a typical corn crib installation. It consists of a 36-in die-cast aluminum fan directly mounted on a 5-hp Delco motor. The Crop-Drier is available with either a 1- or 3-phase motor equipped with overload protection and sealed ball bearings. Measuring only 43½ x 43½ x 12 in, the entire unit can be easily moved about the farm. The unit requires only an across-the-line starter and is sold with a 12-month warranty.

• • •

Nozzle for Wide-Area Spraying. Spraying Systems Co., 3226 W. Randolph St., Bellwood, Ill., announces a new nozzle that gives a spray pattern up to 30 ft wide. The ¾ TOC single-swivel nozzle is built with an off-center orifice tip and when properly mounted will produce a spray ranging from about 15 to 30 ft in width. The width of the



Spraying Systems nozzle for wide-area spraying

spray depends upon the nozzle size, line pressure and elevation of the spray. Comparative uniformity of spray pattern is maintained. The nozzle is made of brass and can be supplied in various tip sizes for various capacities. It is especially adapted for spraying areas inaccessible or difficult to reach by standard spray booms. For complete information write the company for data sheet 4629.

• • •

Link-Belt Worm-Gear Drives. Link-Belt Co., Chicago 1, Ill., illustrates, describes, and tabulates in a new 80-page book, No. 2324, worm-gear drives of three basic types, each available in 10 different sizes, for fractional or large horsepower in speed ratios of 3⅜ to 1 up to 8000 to 1. Features enumerated for these enclosed right-angle drives are compact design, anti-friction bearings, automatic splash lubrication, high ratios in small space, operation at high input speeds, quiet performance, and their availability for vertical or horizontal driving. A portion of the book contains typical drive problems with their solutions and shows the ease with which the proper drive may be selected for a specific duty. A copy will be forwarded to any interested reader upon request direct to Link-Belt Co.

Step Up

to an OLIVER Tractor

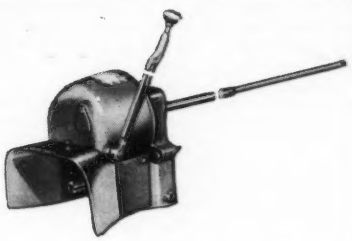
Step up into the seat of an Oliver Tractor for a new realization of what advanced design and exclusive features can give you.

The rubber-torsion spring seat cradles you in a comfortable, shockless ride. Hydra-lectric* control gives you mastery of tools to *any* depth setting at a touch of your finger . . . without leaving the seat. The Direct Drive Power Take-Off frees you from the old limitations in operating baler or combine. Extra speeds in forward and reverse . . . a high compression engine which likes to lug under load . . . the easiest steering you ever encountered . . . the list is almost endless.

Having worked an Oliver Tractor you will leave that seat with reluctance. You will be comparing any tractor you drive in the future with this *one* tractor which gives you so much more.

Oliver Dealers at the sign of the Oliver Shield are ready now to demonstrate the tractor of tomorrow that is here today. The OLIVER Corporation, 400 West Madison Street, Chicago 6, Ill.

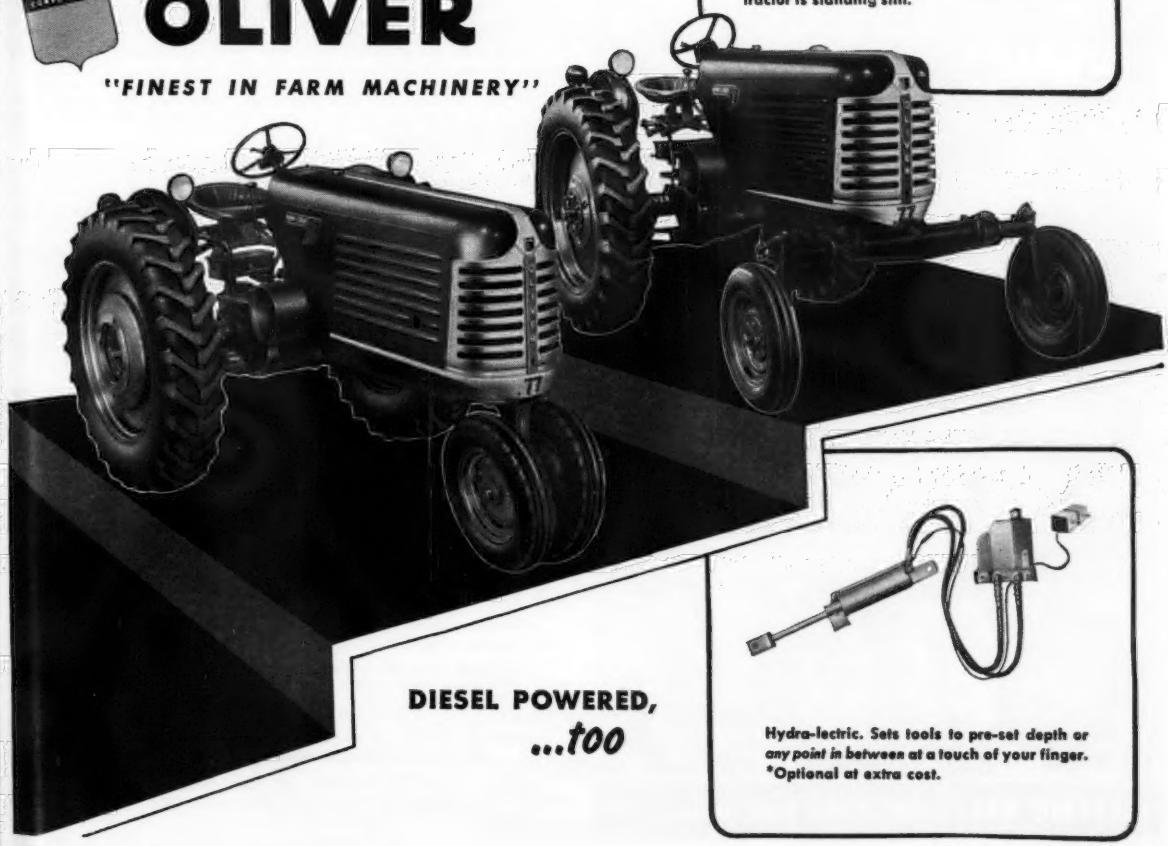
Standard on all Oliver Wheel Tractors. The extra comfort seat with torsion springs of rubber.



Only Oliver can give you this advanced feature—the Direct Drive constant running Power Take-Off. Independent of the transmission. Has its own clutch and runs when tractor is standing still.

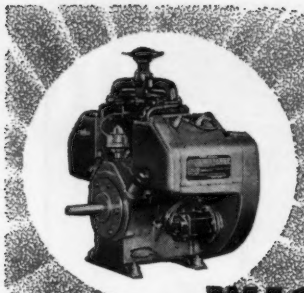
OLIVER

"FINEST IN FARM MACHINERY"



DIESEL POWERED, ...too

Hydra-lectric. Sets tools to pre-set depth or *any point in between* at a touch of your finger. *Optional at extra cost.



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PEAK PERFORMANCE
15 to 30 H. P
V-Type
Four-Cylinder
WISCONSIN
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Model VE-4, V-type 4-cylinder standard engine 21.5 hp. at 2400 rpm.

HEAVY-DUTY Air-Cooled

On power jobs that call for rugged serviceability and sustained operation in the 15 to 30 hp. range, Wisconsin 4-cylinder engines rate *first preference* on the basis of such features as:

Trouble-free Air-Cooling at all temperatures from sub-zero to tropical highs; tapered roller bearings at BOTH ends of the extended crankshaft to take up all thrust and radial loads (also inherently self-cleaning); rotary type, high tension OUTSIDE Magneto equipped with Impulse Coupling for quick starting in any weather and sure firing on the job; individual oil stream to each connecting rod (other parts lubricated by oil spray) assuring complete and thorough lubrication at all times.

V-type design permits a shorter crankshaft and less height than with a "straight-in-line" engine, assuring a more compact power unit.

4-cycle single cylinder models, 3 to 9 hp., and 2-cylinder models, 7 to 13 hp., also available. Detailed data on request.

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 14 WISCONSIN

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Designed to do the Job

For more than fifty years we have built dependable steel wheels for movable equipment . . . agricultural and industrial.

You can rely on EWC engineers to recommend the correct wheels for your unit. This is particularly valuable when new machines or new models are being considered.

If one of our standard wheels is not the most efficient, we can design and manufacture special wheels.

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Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Aeilts, Lester W.—Agr. engr., irrigation res., Missouri Oake District, Bureau of Reclamation, USDI. (Mail) 619 13th S.W., Huron, S. D.

Christensen, Milton C.—Partner and agr. engr., Agricultural Service and Engineering, 222 Idaho St., Gooding, Ida.

Corkery, Leon J.—Engr. trainee (design), John Deere Harvester Works, East Moline, Ill.

Corrigan, C. D.—Service trainee, Massey-Harris Co., Ltd. (Mail) 70 Roxborough Dr., Toronto 5, Ont., Canada

Coughran, Samuel J.—Field and des. engr., Port-Alum Irrigation Co., Vista, Calif. (Mail) RR 2, Box 1130

Crown, Richard E.—Student, Ohio State University. (Mail) RR 1, Nashport, Ohio

Cushing, Glen—Laboratory supervisor, Puget Sound Power and Light Co., Puyallup, Wash.

Garrison, H. K.—Engr., industrial res. div., Doane Agricultural Service, 5144 Delmar, St. Louis 8, Mo.

Hardy, Gresham G.—Sales rep., B. F. Goodrich Co. (Mail) 2205 Lincolnwood Dr., Evanston, Ill.

Haroldsen, Fred O.—Partner and agr. engr., Agricultural Service and Engineering, 222 Idaho St., Gooding, Ida.

Harrison, Alan J.—Zone mgr., International Harvester Co., Ltd. (Mail) 660 Wall St., Winnipeg, Man., Canada

Hawkins, Gordon—Sales mgr., Northwest Sprinkler Irrigation Co., East 2402 Trent Ave., Spokane, Wash.

Heft, Marvin E., Jr.—Farm service advisor, Consumers Power Co. (Mail) Sparta, Mich.

Johnson, Loyd—Student, Alabama Polytechnic Institute. (Mail) RR 2, Somerville, Ala.

Johnston, Douglas—Engr., des. and dev., John Blue Co., Inc., Huntsville, Ala.

Maloney, Fred G.—Engr., Edwards Equipment Co., 4312 S. First St., Yakima, Wash.

McKenzie, Bruce A.—Jr. asst. agr. engr., Agricultural Engineering Dept., Purdue University, Lafayette, Ind.

McRoy, William D.—Agr. engr. and draftsman, agricultural engineering dept., Tennessee Coal, Iron and Railroad Co., Box 2634, Birmingham 2, Ala.

Mogg, William R.—Sales engr., Cleveland Graphite Bronze Co., 332 S. Michigan Ave., Chicago 4, Ill.

Orr, Robert C.—Appraiser, Coast Federal Savings and Loan Assn. (Mail) 436½ W. Lemon St., Monrovia, Calif.

Perez, Manuel R. y—Student, mech. eng. dept., University of Missouri, Columbia, Mo. (Mail) 1215 Paquin St.

Petri, Michael—Zone mgr., International Harvester Co. (Mail) 527 E. 65th, Vancouver, Wash.

Prowell, Richard O.—Agr. engr. (SCS), USDA (Mail) Box 1147, Hermiston, Ore.

Scott, H. Zane—Des. engr., John Deere Harvester Works, East Moline, Ill.

Sherman, Roger M.—Des. engr., W. R. Ames Co., 150 Hooper St., San Francisco 7, Calif.

Tucker, W. D.—Gen. mgr. and secretary-treasurer, John Blue Co., Huntsville, Ala. (Mail) P.O. Box 139

Unbewust, John S.—Sr. experimental aide, State College of Washington. (Mail) U.S. Development Farm, Winchester, Wash.

van Heerden, S. J. P. K.—Graduate student in agr. engr., Michigan State College, East Lansing, Mich. (Mail) 481 E. Shaw

Winters, Eugene P.—Soil scientist, Santiam Soil Conservation District, Stayton, Ore.

Zabradnik, John W.—Res. fellow in agr. engr., Iowa State College, Ames, Iowa

TRANSFERS OF MEMBERSHIP GRADE

Bockhop, Clarence W.—Service mgr., The Stewart Co., 5115 East Grand, Dallas, Tex. (Junior Member to Member)

Davis, Chester P., Jr.—Assoc. agr. engr., farm elecn. div. (BPISAE), USDA, Agricultural Research Center, Beltsville, Md. (Junior Member to Member)

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BEARINGS ENGINEERED BY SKF

Modern combines, as built by John Deere Harvester Works, not only cut the crop . . . they thresh the grain clean, completely separate it from the straw, give it a final cleaning before it's hauled to the elevator. It's hard work, especially when wet grain builds up shock loads. But Deere's Self-Propelled Combines thrive on it. Friction is kept at the minimum by SKF Self Aligning Ball Bearings on the cylinder shaft . . . bearings that never need adjustment . . . require only occasional lubrication. SKF Bearings have an inherent ability to stand up under the hardest kind of work . . . to function smoothly under highly taxing operating conditions. It is the natural result of constant vigilance over all manufacturing processes . . . ceaseless metallurgical and engineering research that enable SKF to supply exactly the right bearing for the job. **SKF** INDUSTRIES, INC., PHILADELPHIA 32, PENNSYLVANIA—*the Pioneers of the Deep Groove Ball Bearing, Spherical Roller Bearing, Self-Aligning Ball Bearing.* 7115

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BALL AND ROLLER BEARINGS

8 REASONS WHY SKF IS PREFERRED BY ALL INDUSTRY

Integrity — Craftsmanship — Metallurgy — Tolerance Control
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SPRAY NOZZLES

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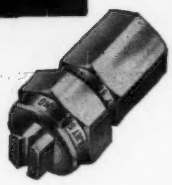

TeeJet Spray Nozzles are precision made to provide uniform distribution . . . in all capacities on all spray rigs and portable sprayers. Orifice tips and strainers in all sizes for all operations . . . may be easily interchanged and spray direction quickly aligned by means of patented V-groove tip design. Write for information and ask for Bulletin 55.

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STANDARD EQUIPMENT ON AMERICA'S LEADING SPRAY RIGS AND SPRAYERS

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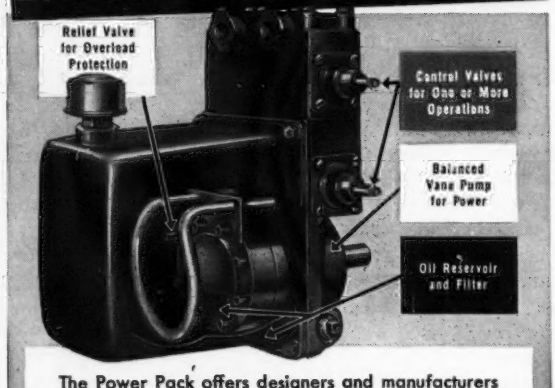
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The Power Pack offers designers and manufacturers a proven and dependable source of hydraulic power in a single compact "package". Hydraulic balance, automatically controlled operating clearances, and built-in overload protection are among the many advantages that make the Vickers Power Pack an outstanding hydraulic equipment value. Saves labor and reduces cost on agricultural implements, construction machinery, materials handling equipment, and industrial machinery.

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FRANK J. ZINK ASSOCIATES

Agricultural Engineers

Frank J. Zink — Earl D. Anderson

Wendell C. Dean

Development - Design - Research - Markets - Public Relations

BOARD OF TRADE BLDG., CHICAGO 4, ILLINOIS • • Tel. HArrison 7-0722

RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of $1.00 per line per issue; 50 cents per line to A.S.A.E. members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.

Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. The Society does not investigate or guarantee the representations made by parties listed. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request. "Agricultural Engineer" as used in these listings, is not intended to imply any specific level of proficiency, or registration, or license as a professional engineer.

NOTE: In this bulletin the following listings still current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated:

POSITIONS OPEN: JUNE—O-355-717, 393-719. JULY—O-360-722, 421-726. AUGUST — O-25-503, 25-504. SEPTEMBER — O-34-506. OCTOBER — O-75-507, 76-508, 46-509. NOVEMBER — O-102-510, 104-511, 108-512, 108-513.

POSITIONS WANTED: JUNE—W-364-393, 387-399, 274-400. JULY —W-337-409, 398-411, 412-413, 417-415. AUGUST—W-5-1, 4-2. SEPTEMBER—W-38-9, 40-10. OCTOBER—W-66-12, 69-13, 73-14, 71-15. NOVEMBER—W-93-16, 72-17, 99-18, 80-19- 109-20.

NEW POSITIONS OPEN

PROJECT ENGINEER for work on corn and cotton planters with a midwestern manufacturer. Want man with experience in corn planter development work, capable of heading planter division and modernizing line of one, two, and four-row tractor-mounted and horse-drawn corn and cotton planters. Good opportunity for right man. Age 35-40. Salary open. O-113-514

NEW POSITIONS WANTED

SERVICE, management, or production work in power and machinery field, with manufacturers, preferably in Northeast. BS deg in agricultural engineering, 1949; Pennsylvania State College. Farm background. Experience 1½ years handling sales and service of farm equipment in retail store. Currently employed as manager of the department. War service 3 years in Civil Engineering Corps, U.S. Navy. Married. Age 26. No disability. Available on reasonable notice. Salary open. W-81-21

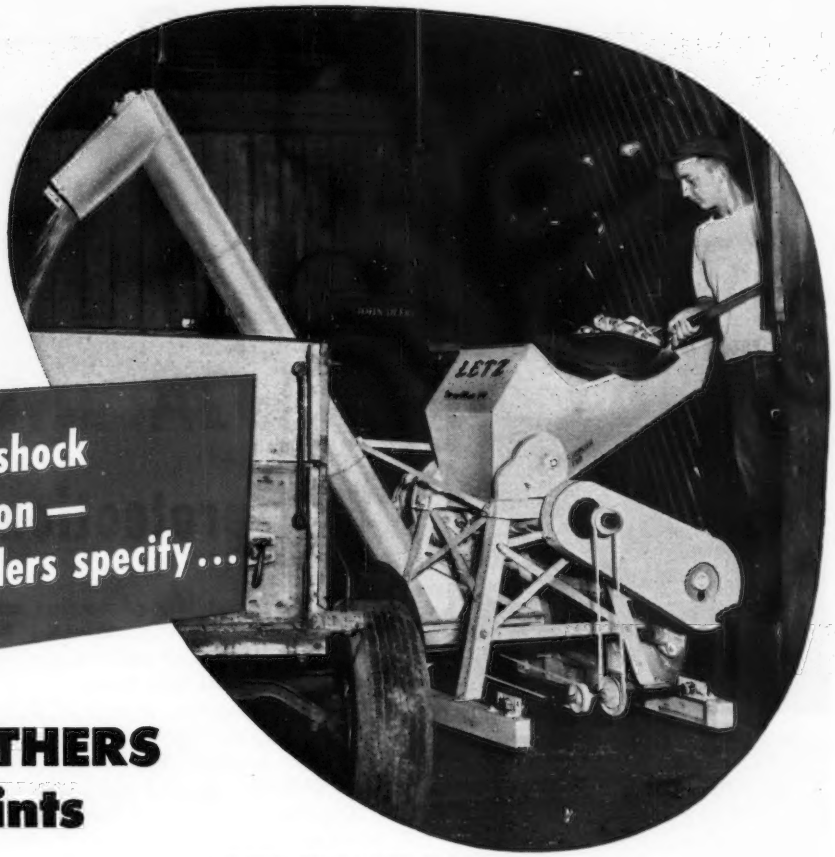
SALES or service in power and machinery or rural electric field with manufacturer. Work location in West or in South America. BS deg in agricultural engineering expected in January, Louisiana State University. Farm background. Experience as auto mechanic and as logger. War enlisted combat service in navy 2½ years, as hydraulic gun mount specialist. Married. Age 25. No disability. Available February 1. Salary $3000. W-114-22

SALES, service, or writing, in power and machinery field, in industry or public service, anywhere in USA, Europe, or South America. BS deg in agricultural engineering expected in January, Louisiana State University. Part time work experience in agricultural engineering department as student assistant on maintenance and repair of farm equipment. Speak Spanish and French. Single. Age 22. No disability. Available in February. Salary open. W-117-23

Farm Electrification Slide Kit

THE farm section of Edison Electric Institute, 420 Lexington Ave., New York 17, N.Y., has prepared a kit consisting of 88 kodachrome 2x2 slides on the use of electricity in dairy farming, poultry farming, crop processing and handling, and general uses of electricity on the farm. Four 30-minute scripts are also included in the kit. All the slides are action shots illustrating farm electrical equipment in constant use by farmers. The kit was prepared especially for utilization by speakers on farm electrification sales programs.

on corn shellers...
stalk choppers...
burr mills...
hammer mills...



where extreme shock loads are common — implement builders specify...

BLOOD BROTHERS Universal Joints

On all kinds of implements — for all sorts of heavy farm jobs — you'll find Blood Brothers Universal Joints. And what's the reason?

Simply this: Blood Brothers Joints have proved in the past — and continue to prove every day — that they get the power through dependably. On jobs like this, for example, drive line universals take a beating when a piece of metal or rock hits the grinding plates.

But Blood Brothers Universal Joints can "take it" and come back for more time after time. They're tough — and they last! That's why...

THESE FIRMS USE BLOOD BROTHERS UNIVERSAL JOINTS ON:

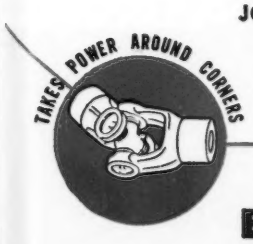
CORN STALK CHOPPERS AND OTHER TYPES
Barrentine Mfg. Co.
Brady Mfg. Co.
Central Texas Iron Works (Perry Co.)
Coats Loader & Stackers Inc.
Durabilt Mfg. Co.
Grant Mfg. Co.
Horn Mfg. Co.
Lilliston Implement Co.
Lundell Mfg. Co.
Mooers Machine Works
Olson Mfg. Co.
Schield Bantam Co.
Servis Equipment Co.
Silbaugh Mfg. Co.
Wood Bros. Mfg. Co.

CORN SHELLERS
Red Cross Mfg. Co.

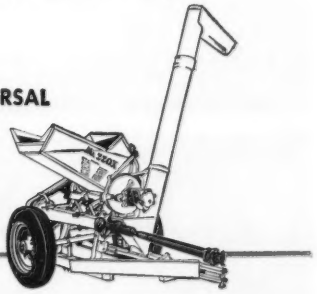
BURR MILLS
N. P. Bowsher Co.
Letz Mfg. Co.

HAMMER MILLS
Gehl Bros. Mfg. Co.
Mooers Machine Works
Viking Mfg. Co.
Wetmore Pulv. & Machy. Co.

FOR FARM IMPLEMENTS, MORE BLOOD BROTHERS UNIVERSAL JOINTS ARE USED THAN ALL OTHER MAKES COMBINED



On this Grinder, the Blood Brothers heavy-duty slip joint assembly includes adjustable safety slip clutch.

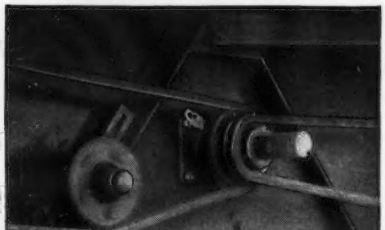


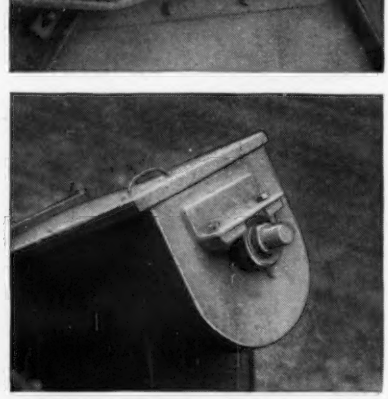
BLOOD BROTHERS machine co.
Agricultural Universal Joints
ALLEGAN, MICHIGAN
Division of Standard Steel Spring Company . . . Chicago Office: 122 S. Michigan

100% Fafnir Equipped

FAFNIR UNITS ARE PAYING OFF IN SPOTS LIKE THESE.

G. E. Price Pickup Bean Thresher





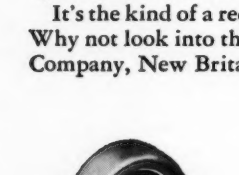
Self-protection . . . or else.

There is no coddling of bearing units on this forty foot long G. E. Price Pickup Bean Thresher. Bearings are right out in the open, operating constantly in a smother of dust and dirt. Self-protection is their only hope.

Season after season of uninterrupted service by scores of Fafnir Ball Bearing Pillow Blocks and Flange Cartridges with famous dust-tight, grease-tight Mechani-Seals has convinced the producer of these machines that a 100% Fafnir specification is a wise policy.

The original model of this machine used plain bearings. Conversion to Fafnir Ball Bearing Units reduced horsepower demand by one-half, fuel consumption by two-thirds.

It's the kind of a record you may be looking for in your machines. Why not look into the possibilities of Fafnirs? The Fafnir Bearing Company, New Britain, Conn.



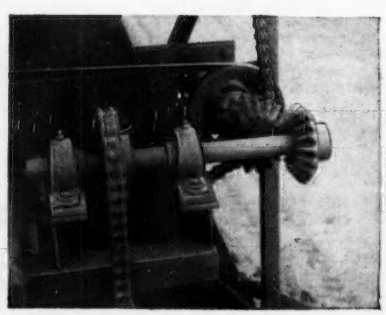
Fafnir Type LAK Ball Bearing Pillow Block with Mechani-Seals.

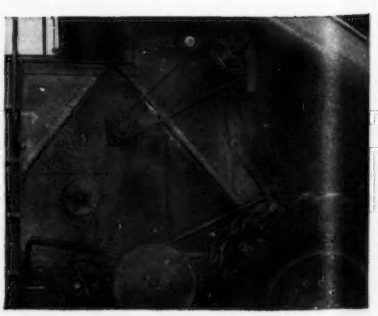
Fafnir Type LCJ Ball Bearing Flange Cartridge with Mechani-Seals

FAFNIR

BALL BEARINGS

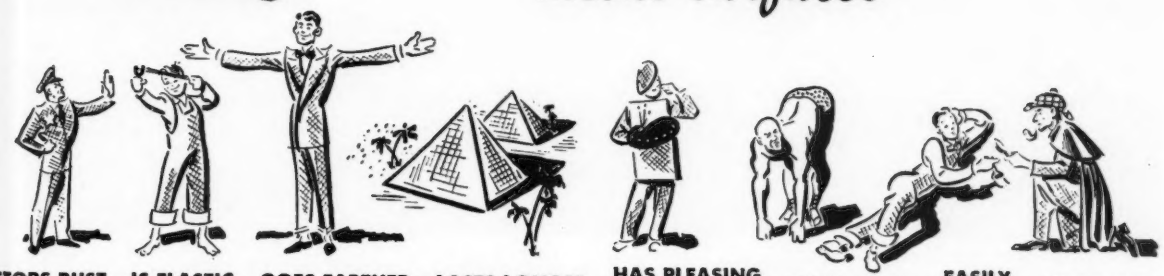
MOST COMPLETE LINE IN AMERICA





MZP
METALLIC ZINC PAINT

is the ideal protection for metal surfaces



STOPS RUST...IS ELASTIC...GOES FARTHER...LASTS LONGER... HAS PLEASING APPEARANCE ...STICKS FAST... EASILY APPLIED ...HIDES RUST

Stops Rust—Zinc oxide and metallic zinc dust replaces rust-stopping zinc lost where galvanizing wears thin! *Elastic*—MZP film expands and contracts with metal to maintain unbroken coating! *Goes Farther*—Gallon covers 600 to 800 sq. ft., about twice the area of many paints. *Lasts longer*—In actual tests MZP has given complete rust protection longer than any other paint! *Has Pleasing Appearance*—Paint film dense & smooth and available in attractive colors! *Sticks Fast*—Made especially for metal, it won't "check" or peel! *Easily Applied*—By brush or spray, goes on fast and uniform! *Hides Rust*—Completely obscures even darkest rust discolorations! Scientific, long-period use tests under all exposure conditions by paint manufacturers, agricultural colleges and the American Zinc Institute, as well as actual use by thousands of farmers have proved MZP the ideal protective paint for metal surfaces. In addition, MZP has stood the test of time, giving extraordinary service for nearly a century in Europe and more than 25 years in this country. Send for booklets below.

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The free booklets offered in the coupon at right are fully illustrated and packed with practical information on galvanized sheets, roofing installation, Metallic Zinc Paint, etc. Send for those you can use, today!

SEND US THIS COUPON ➡

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Chicago 1, Illinois

Without cost or obligation, send the illustrated booklets I have checked.

- ☐ Facts About Galvanized Sheets
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- ☐ Directions For Applying Galvanized Sheets
- ☐ Repair Manual on Galvanized Roofing & Siding
- ☐ Use Metallic Zinc Paint to Protect Metal Surfaces

NAME_____

ADDRESS_____

TOWN & STATE_____

THE DANUSER DIGGER is adaptable to most tractors. More than 20,000 are in service. Conveying flights of the auger are of low alloy high strength steel containing nickel . . . with replaceable hardened cutting edges, and replaceable heat treated point. Auger sizes: 4", 6", 9", 10", 12", 14", 18", and 24". Manufacturer: *Danuser Machine Company, Fulton, Mo.*

How to Dig Holes
. . . Sitting Down!

The modern way to dig holes for fence posts, seedling settings and farm construction work is a one-man operation . . .

With the Danuser Digger, shown above, the hydraulic system of the tractor actuates the up and down movements of the auger.

Rocks and stones never daunt this earth-drill. The conveyor flights of the auger resist impact, splitting, chipping and abrasion, because they're made from a low alloy high strength steel containing nickel. This steel is produced under the trade name, "Yoloy," by Youngstown Sheet & Tube Company of Youngstown, Ohio.

High strength low alloy steels containing nickel provide mechanical properties that are especially suited for agricultural use. They are strong, rugged and tough. Moreover, by resisting impact, wear, erosion and many types of corrosion, these steels help substantially to lengthen equipment life.

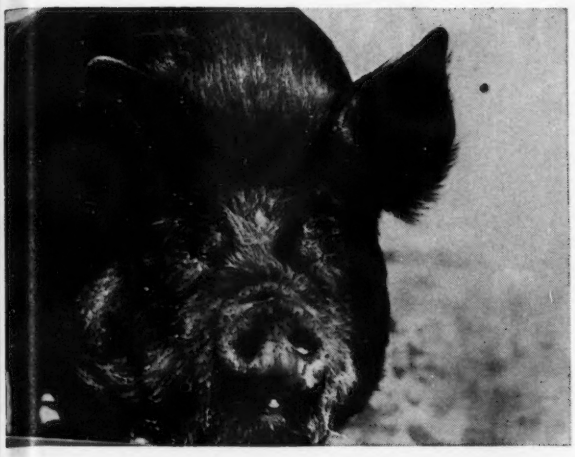
Steels of this type assure maximum weight reduction without sacrifice of strength or safety. Moderate in cost, and produced under various trade names by leading steel companies, high strength steels containing nickel along with other alloying elements pay for themselves.

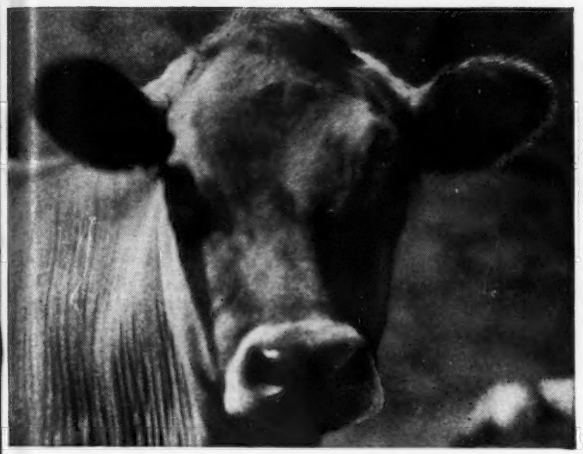
A list of sources of supply will be furnished on request.

EMBLEM OF INCO SERVICE

Because of unusually heavy industrial and defense demand, rationing of nickel has been in force since July 1st. However, we believe that dissemination of technical data and service experience can help to promote the intelligent utilization of critical materials, so essential in these times. We shall, therefore, continue to issue information on new developments and user experience with nickel-containing materials.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.





Each developed for a special purpose

Farmers *select* and breed livestock to serve them best in special ways. Just so have Armco Special-Purpose Steels been developed to enable the manufacturer to serve the farmer best.

Manufacturers know that their products serve better when the steel is carefully selected for the purpose. When they want their products to resist atmospheric corrosion — such as in grain storage bins and brooder canopies — they prefer Armco ZINCGRIP. The protective zinc coating on this special steel will not peel or flake along the edges or at corners. To guard against underwater corrosion — as in heated hog waterer service — there is durable Armco Stainless Steel. If the product is to be painted Armco ZINCGRIP-PAINTGRIP Steel is Bonderized at the mill to take paint readily and hold it longer.

The famous Armco trademark stands for superior metals "tailored" to do a particular job well — whether it is farm implements, storage bins, stock tanks, farm machinery or dairy equipment.

For 50 years Armco Steel Corporation has worked to *decrease* the cost and *increase* the service life of special-purpose metals.

50th ANNIVERSARY SPECIAL PURPOSE STEELS

ARMCO STEEL CORPORATION

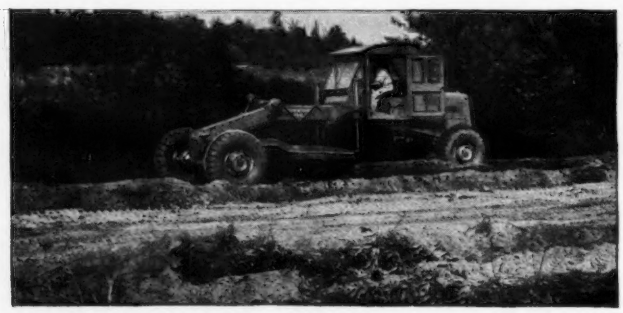
HEADQUARTERS AT MIDDLETOWN, OHIO, WITH PLANTS AND SALES OFFICES FROM COAST TO COAST • THE ARMCO INTERNATIONAL CORPORATION, WORLD-WIDE

ARMCO

This Montana ditch is relatively deep and narrow.

This Texas ditch is 3 feet deep and 9 feet wide.

Constructing one of a series of closely spaced field drains.



Spreading a neglected spoil bank.

there's a **JOB** to be done

Ditches to Cut

Cutting a ditch for farm tile.

The Bulldozer Attachment removes a high spot.

Drainage and irrigation are the big problems in many parts of the country. Here is another place where the power, speed and all-around versatility of the A-W Power Grader can be used to excellent advantage.

AUSTIN-WESTERN COMPANY, AURORA, ILLINOIS, U.S.A.

BUILDERS OF ROAD MACHINERY

Austin Western

SINCE 1859

AGRICULTURAL ENGINEERS *slash costs, keep quality with...*

MORSE DOUBLE PITCH ROLLER CHAIN

If your costs are increasing and you won't sacrifice quality, then Morse Double Pitch Roller Chain is your economical answer.

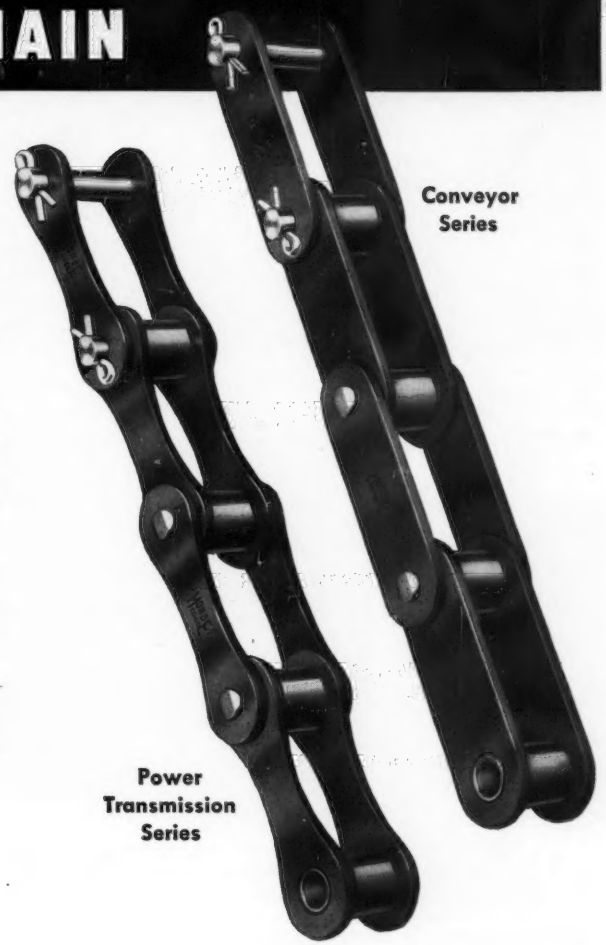
Morse Double Pitch Chains are made with the same exacting precision as are Morse Standard Roller Chains. They give you the same strength and positive power transmission with less weight, less cost. They save space, operate efficiently on long or short centers and maintain accuracy between two parallel strands.

Morse Double Pitch Roller Chain is available in the Power Transmission series (contour-design side plates) and the Conveyor series (straight, heavy-duty side plates) made to American Standards from 1" pitch to 2½" pitch. Conveyor series is stocked with both standard and large rollers. Standard attachments available.

Look twice and see if Morse Double Pitch Roller Chain isn't the answer to your mechanical power transmission problems. Ask the Morse man for further information. Or write:

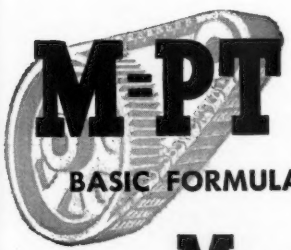
MORSE CHAIN COMPANY

Dept. 578, 7601 Central Ave., Detroit 8, Mich.



Conveyor Series

Power Transmission Series



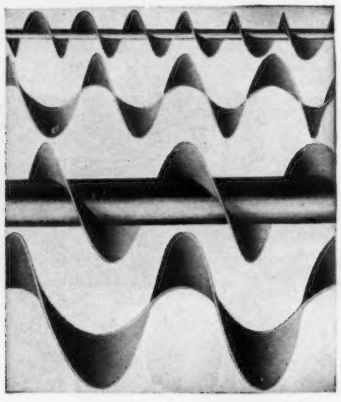
Morse *means* Power Transmission

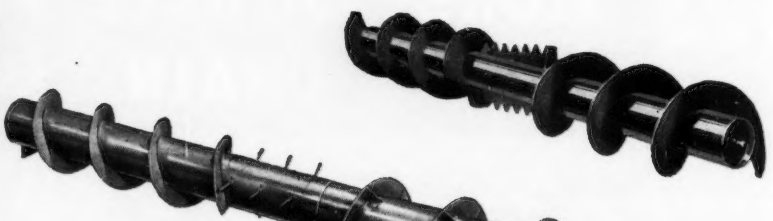
MORSE

MECHANICAL *POWER TRANSMISSION* PRODUCTS

PRODUCTS OF BW BORG-WARNER

LINK-BELT SCREW CONVEYOR-





▲ These views suggest the wide variety of diameters, pitches and gauges of screw conveyor, in continuous and sectional flight types, as manufactured by Link-Belt. Flighting can be furnished mounted or unmounted.

Post hole diggers make good use of the boring and elevating ability of Link-Belt Screw Conveyor.

▼

▲ As an "auger" for gathering the cut grain back of the sickle bar, the screw conveyor has come standard equipment on the modern combine. Link-Belt Helicoid (continuous rolled flighting) is mounted large diameter tube to form a single, efficient unit.

A well known hay baler employs Link-Belt Screw Conveyor as a feeding mechanism to gently but firmly feed the hay into the press chamber.

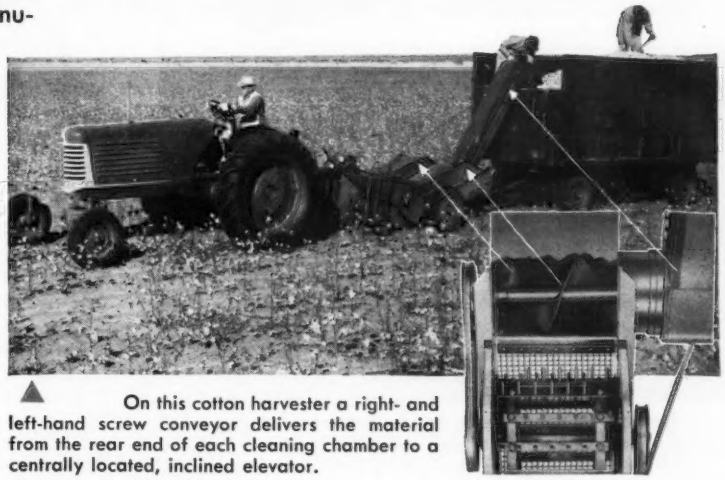
▶

Vital part of modern farm machinery

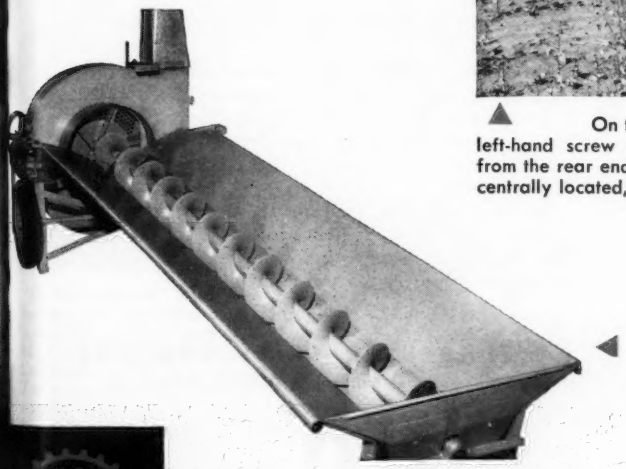
e jobs Link-Belt Screw Conveyor can perform re becoming more and more numerous as ngineers utilize its unique qualities—simplicity, ggedness, uniform construction and availa- ility in a wide range of diameters, pitches and auges. Not only adapted to conventional con- eying, this versatile element is also finding creased employment for elevating, digging, ixing, spreading and feeding applications.

Through many years experience and with xcellent production facilities, Link-Belt Com- any is especially well equipped to supply rew conveyor and flighting, either continu- s rolled "Helicoid" or sectional flight. nk-Belt engineers will gladly cooperate ith you in making effective use of Link- elt Screw Conveyor in your new design.

▲ On a manure spreader, two short sections of Link-Belt Screw Conveyor, opposite hand, give very effective scattering action.



▲ On this cotton harvester a right- and left-hand screw conveyor delivers the material from the rear end of each cleaning chamber to a centrally located, inclined elevator.



This Link-Belt Screw Conveyor in a forage blower is a dependable means of feeding material from collecting hopper into the blower fan.

12,212

LINK-BELT COMPANY

Chicago 8, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg. Offices in Principal Cities.

Farm homes designed for better farm living

from the Weyerhaeuser 4-Square Farm Building Service

Several modern farm homes have been added to the Weyerhaeuser 4-Square Farm Building Service. All agricultural people, we believe, will be interested in reviewing these homes and their floor plans.

For these new farm homes offer today's farm families the best in modern living comforts, conveniences and facilities—and do so with economy.

In designing these homes the comfort and service requirements of farm living were carefully studied. Architects and engineers working with home economists and extension specialists have provided features that serve farm needs. All areas of the home have received the benefits of professional planning.

The kitchens are planned for brightness and step-saving convenience—storage space is abundant—work surfaces of proper height—refrigerator, range and sink are close at hand.

Service rooms adjoining the kitchen provide space for laundering, canning and other chores—as well as facilities for the men to clean up and a place to leave work clothes and boots. The service room is truly a buffer between kitchen and farmyard.

Bathrooms are modern—bedrooms airy with good closet space—the living rooms cheerful and homey.

All homes are carefully engineered for sound, rigid construction—the maximum use of standard in-stock materials—and precision manufactured Weyerhaeuser 4-Square Lumber which fits into place without needless cutting, fitting or material waste.

If you are interested in these modern farm homes, the newest addition to the Weyerhaeuser 4-Square Farm Building Service, we'll be happy to send you elevations and floor plans.

. . .

WEYERHAEUSER SALES COMPANY

First National Bank Building • St. Paul 1, Minnesota

Weyerhaeuser 4-Square

LUMBER AND SERVICES

Invents Reversible Spike Tooth Harrow-

Saves Time and Cost of Sharpening Spikes

Ed Ruffner (left), prominent farmer of Mason, Illinois, explains to Mr. L. Keller (right), Texaco Man of Effingham, that the spikes of his harrow can be set at any desired angle by simply shifting the lever. The drawbar (near Mr. Keller's foot in picture) is easily detached and fastened on the other side of the harrow and the implement pulled from that direction. This is done when the teeth become dull on the land side.

REMOVING dull teeth from harrows and taking them to town for sharpening takes a lot of time and trouble. So Ed Ruffner invented a spike tooth harrow that can be pulled in either direction. When the teeth become dull on the land side, the drawbar is detached and fastened on the other side and the harrow pulled from the opposite direction. Thus the teeth are always kept sharp for effective harrowing.

Ed Ruffner, like keen farmers the country over, has also discovered that *it pays to farm with Texaco Products.*

Texaco Man Leonard Budde fills Mr. Ruffner's tank with Fire-Chief, the gasoline with superior *"Fire-Power,"* as Mr. Ruffner looks on. Timely, neighborly service is the kind farmers appreciate *and get* from their Texaco Men.

"Custom-Made Havoline outperforms not only Premium oils but good heavy-duty motor oils, too," says Texaco Man Bob Baynham (right), of Pomona, California, to Mr. E. H. Saugstad (left). Tests showed Havoline had twice as tough an oil film as many of the best Premium oils. That means longer engine life.

Busy farmers, like Foreman Roy Mull of the E. M. Carter Farm, Plainview, Texas, put Texaco PT Anti-Freeze in their radiators, for it stays **PuT** all winter. It's permanent type, anti-boil and anti-rust, too. Order some from your Texaco Man today.

TUNE IN... Metropolitan Opera broadcasts every Saturday afternoon. See newspaper for time and station.

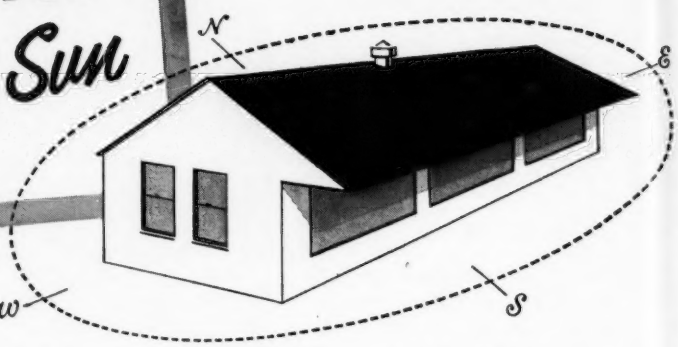
TEXACO
REG. T.M.
THE TEXAS COMPANY

IT PAYS TO FARM WITH TEXACO PRODUCTS

DIVISION OFFICES: Atlanta 1, Ga.; Boston 17, Mass.; Buffalo 3, N. Y.; Butte, Mont.; Chicago 4, Ill.; Dallas 2, Tex.; Denver 1, Colo.; Houston 1, Tex.; Indianapolis 1, Ind.; Los Angeles 15, Calif.; Minneapolis 2, Minn.; New Orleans 6, La.; New York 17, N. Y.; Norfolk 1, Va.; Seattle 11, Wash.

Texaco Petroleum Products are Manufactured and Distributed in Canada by McColl-Frontenac Oil Company Limited.

How to locate farm structures for *Best Use of the Sun*



By proper building location and window treatment you can provide better year-round environment to help keep livestock and poultry more healthful and more productive. In summer . . . cooler, well-daylighted buildings. In winter . . . drier interiors, better sanitation and greater warmth.

The provision of adequate daylight calls for large windows properly located and insulated with *Thermopane**. This double-glass unit traps sun heat or animal heat inside the building, thereby protecting the animals from sudden temperature changes and providing a generally improved environment for them.

Solar design also calls for methods of control, you want to bring in winter sun . . . you don't want summer sun, except in early morning or before cool evenings. The diagrams and paragraphs below serve as limited guides for building orientation for sun control.

SOME TYPES OF SHADING

OVERHANG—can be a roof extension, a separately-built unit, or awnings. Angle of the device should be calculated according to sun positions.

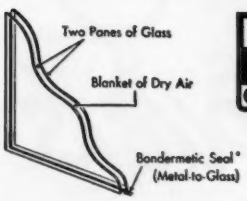
FOLIAGE — vines, shrubs and deciduous trees are excellent shading devices, but let winter sun through.

SIDE VANES — for some east and west exposures, side vanes, either solid or vine-covered, may be used.

WHY THERMOPANE INSULATING GLASS MAKES SOLAR HEATING PRACTICAL

Thermopane's two panes of glass and sealed-in dry air create a heat trap. The sun's rays enter the building in short wave lengths which the glass transmits. Once within the building the heat is re-radiated at longer lengths which are not transmitted by *Thermopane*. Outward conduction of the heat is minimized by *Thermopane's* air space. The heat transmission factor for *Thermopane* with ½" air space is .58, compared with 1.16 for single glazing. Warmth brought in as sunlight, thus stays in the building longer.

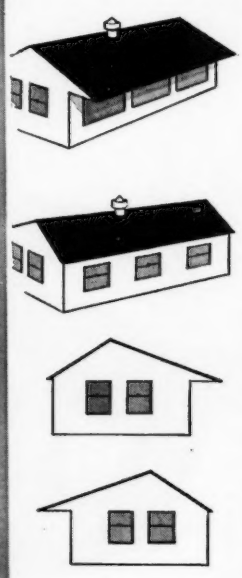
Thermopane is sold by glass and building supply distributors and dealers. Write for our *Thermopane* literature. And feel free to write us on problems in glazing farm buildings. *®



L O F GLASS

Thermopane

MADE ONLY BY LIBBEY·OWENS·FORD GLASS COMPANY
27125 Nicholas Building, Toledo 3, Ohio



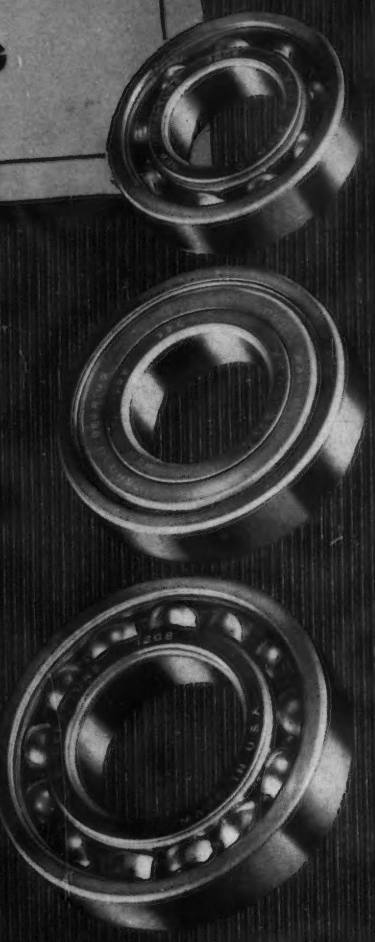
SOUTH — for maximum solar heat input in winter provide a large window area facing south. An important element is the extended roof or other overhang. It lets in the low winter sun, but can completely shade windows from high, hot summer sun. With proper data on window height, building height and latitude it is possible to compute the right amount of overhang. On request, we can assist you in this.

NORTH — use these windows for ventilation and to bring in north daylight. No overhang is recommended.

WEST — shade should be provided to keep out afternoon summer sun. Shrubs or trees are effective—their lack of foliage in winter permits late sun to warm the interior before the cool night sets in.

EAST — windows admit daylight to make the interior brighter and cheerier. An overhang can be used to keep out high morning sun in summer.

Best Things in Life are Free – RUNNING



Friction has some use
but mostly it is
freedom from friction
this world needs.
In machines, that freedom is
essential to long, useful life.
Ball bearings give you most,
New Departure makes them best.

Nothing Rolls Like a Ball...

NEW DEPARTURE
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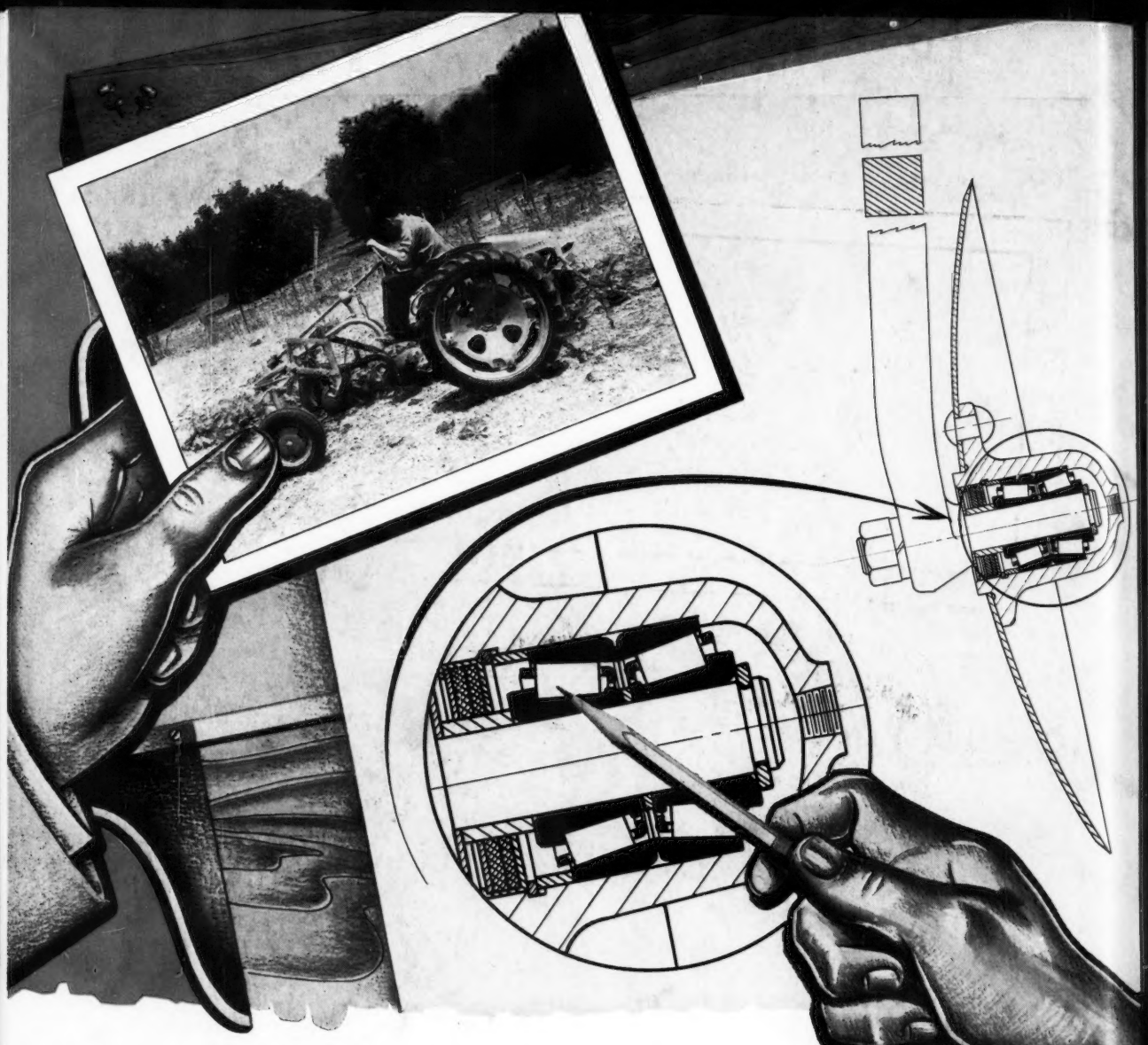

NEW-TYPE CONCAVE COULTER DESIGN BY ALLIS-CHALMERS SPECIFIES TIMKEN® BEARINGS

Another proven design of interest to agricultural engineers is the special concave coulter built by Allis-Chalmers for use with their front-mounted Model G tractor plow.

This Timken Bearing Equipped coulter was designed to cut trash, serve as a jointer, and at the same time offset any possible side draft to the tractor on which the plow is mounted.

The Timken bearing cups are mounted back-to-back in this design with a ground spacer fitted between the cones to set bearing adjustment. Both cups are clamped in the hub with a spacer and snap ring. Located on the pin against a snap ring, the entire Timken bearing assembly is bolted and locked in place with a nut and lock washer.

You may obtain other important typical implement designs by writing for your copy of the Farm Equipment Section to the Timken Engineering Journal. It will be an important addition to your design library. Write today. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

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TAPERED ROLLER BEARINGS

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